

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1907.

GENERAL PHYSICS.

773. *Interference Extensometer.* E. Grüneisen. (Zeitschr. Instrumentenk. 27. pp. 38-51, Feb., 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—Describes, with illustrations, an instrument by which elastic extension of test-pieces of metals is measured, using the principle of Haidinger's rings. The elastic modulus is given for about 25 various metals and alloys, together with the chemical composition and density, and modulus as observed by transverse vibrations, and in a few cases the modulus found by longitudinal vibrations. The results obtained by means of the instrument for rhodium and iridium respectively in static tension were 28,000 and 52,500 kg. per mm.², and by transverse vibrations 32,500 and 52,900 kg. per mm.². For the greater part the results given by the several methods are in good agreement. F. R.

774. *Self-inking Pen for Recording Instruments.* E. Preuss. (Zeitschr. Instrumentenk., Beib. 4. pp. 33-35, Feb. 15, 1907.)—Describes, with illustrations, a pen whose differences from the ordinary kinds are that the exit for the ink is at the lower end of a tube, and has a projecting lower lip of definite shape. This form enables the pen to draw a longer line or to work for a longer time than the usual pen. The self-feeding arrangement consists of a tube, part of which is flexible, one end of which dips beneath the surface of the ink in a reservoir, the other beneath the ink in the pen. The tube is partially exhausted of air, and by adjustments of relative level the ink is led to the pen and the supply regulated. F. R.

775. *Compensation of Aneroid Barometers for Temperature.* H. Hergesell and E. Kleinschmidt. (Beiträge z. Physik d. freien Atmosphäre, 1. pp. 108 and 208, 1905. Zeitschr. Instrumentenk. 27. pp. 87-88, March, 1907. Abstract.)—The registering instruments of balloons have to measure pressure differences of 700 mm. and temperature differences of 80° C. The authors show theoretically that a Bourdon tube can be compensated for temperature only when the pressure is constant. If the compensation were made for about 760 mm., the great heights would be registered too small. It is best to adapt the compensation to the maximum heights reached, 10 to 12 km., in

which the temperature will as a rule be lowest, and to pressures of 150 or 100 mm. In the experiments the whole instrument is placed under the pump. The resulting formulæ reduce the testing to the determination of two constants at widely differing temperatures. Examples prove that heights of 15 km. are now recorded correctly within 1 per cent. H. B.

776. Equilibrium of Cyclic Elastic Bodies. L. Rolla. (Accad. Lincei, Atti, 16. pp. 101-108, Jan. 20, 1907.)—To verify Volterra's theory [see Abstracts Nos. 1674 (1906) and 1984 (1906)] the author uses a lecture apparatus founded upon accidental double refraction produced in an isotropic body by strain. The body best adapted to this purpose is gelatine, in which this double refraction is particularly high, and the method is based upon the theoretical researches of Voigt [Abstract No. 838 (1902)]. Hollow cylinders with very thick walls were cast, either complete or cut by partitions parallel to the axis, and variously distributed. Polariscopes were mounted in various ways so as to observe the double refraction either through one or both walls. The pieces of the cylinders cast with partitions were melted together and stuck with their end surfaces to boards. The distribution of the regions under tension and pressure could be exhibited on a screen. In the case of the uniform cylinders, the cylindrical surface separating the two strained regions was midway between the outer and inner surfaces; and in the patched cylinders distributions were found to be in accord with Volterra's theory. E. E. F.

777. Elastic Modulus for Small Loads at the Elastic Limit. H. W. Bearce. (Phys. Rev. 24. pp. 191-194, Feb., 1907.)—The results were obtained by bending the specimens until permanent set was found upon removal of the load, and, upon continuing loading by very small amounts, observing strain by means of an interferometer. In the following table the first column gives the author's results, the others C. P. Weston's [Abstract No. 1619 (1899)] for comparison, the modulus being expressed in c.g.s. units. It is concluded

	At Elastic Limit (Interferometer).	Ordinary Conditions (Interferometer).	Ordinary Conditions (large loads used).
Iron	20.96×10^{11}	—	—
Steel	21.04×10^{11}	19.19×10^{11}	19.56×10^{11}
Copper	12.26×10^{11}	11.87×10^{11}	12.00×10^{11}
Brass	11.59×10^{11}	10.64×10^{11}	10.62×10^{11}

that a slight increase in the modulus occurs when the elastic limit is reached, but, within the limit of errors, Hooke's law is applicable at the elastic limit as well as at lower stresses. F. R.

778. Failure of a Steam Dome under Test. C. Bach. (Zeitschr. Vereines Deutsch. Ing. 51. pp. 465-468, March 28, 1907.)—Gives results of tensile, bending and punching tests of the steel, in the cold and at temperatures up to 800° C., and also in the annealed state, from a steam dome which split almost longitudinally under hydraulic test. It is found that the steel is brittle under shock. It contained C 0.126 per cent, Mn 0.225, and P 0.112 per cent. R. Baumann states that microscopically the pearlite indicates that the plate had been somewhat rapidly cooled. F. R.

779. Strength of Bond in Reinforced Concrete. T. L. Condron. (West. Soc. Engin., Journ., 12, pp. 100-118; Discussion, pp. 118-117, Feb., 1907. Eng. News, 56, p. 658, Dec. 20, 1906. Abstract.)—Tests were made with bars embedded in a 1:2:4 concrete, containing broken limestone not larger than $\frac{1}{2}$ in., and 81 days old. An electric contact spherometer indicated the moment when the bar began to slip in the concrete. The following table gives a summary of the results:—

Slip not more than	Stress, lbs. per sq. in. of Cross-section				Stress, lbs. per sq. in. of Embedded Area.			
	0.01 in.		$\frac{1}{16}$ in.		0.01 in.		$\frac{1}{16}$ in.	
	19	24	19	24	19	24	19	24
Length embedded, inches								
Round	18,700	24,800	30,100*	36,500*	369	178	250*	190*
Square	24,300	25,800	26,900*	37,800*	316	329	341*	242*
23 twists per ft.	26,400	44,800	37,100	46,700	334	301	357	306
28 twists per ft.	24,600	50,600	37,900	53,400	324	353	366	360
Thacker	40,600	57,100	46,600	67,100*				
Corrugated bar, new style ..	37,800	74,500	48,400	80,000*	474	471	613	506
Corrugated bar, old style ..	48,000	79,000	58,000	79,000*	651	636	786	635

* Max. resistance of bond reached before slipping $\frac{1}{16}$ in.

F. R.

780. Fire and Load Test of a Reinforced Concrete Beam. H. B. MacFarland. (Eng. News, 57, p. 382, March 21, 1907.)—The beam, 17 ft. $4\frac{1}{2}$ in. long, was heated up to about 1,000° C. whilst under load, which was maintained constant. The beam sagged whilst the temperature rose, until almost 5 in. out of the straight 8 hours from the start, and upon cooling the total deflection was 8 $\frac{1}{8}$ in. Large pieces of concrete had scaled from the beam.

F. R.

781. Efficiency of the Plug-cock Fog-chamber. C. Barus. (Phil. Mag. 18, pp. 357-364, March, 1907.)—An account of the fog-chamber in theory and practice. If the fog-chamber is combined with a large vacuum-chamber through a sufficiently wide passage-way, containing an ordinary plug gas-cock to be opened and closed rapidly by hand, all the measurable coronas of cloudy condensation due to the presence of colloidal nuclei in wet, strictly dust-free air may be evoked. While such an apparatus admits of capacious fog-chambers and extremely simple manipulation, the author considers that it is probably not inferior in efficiency to any other apparatus.

J. J. S.

782. Changes of Colloidal Nucleation. C. Barus. (Amer. Journ. Sci. 26, pp. 202-210, March, 1907.)—An account is given of the changes of the colloidal nucleation of dust-free moist air with lapse of time. The present is one of a long series of papers on nucleation by the author, and some of the recent observations involve a revision of conclusions previously reached. Amongst other results it appears that nearly 8,000 colloidal nuclei are apparently generated in dust-free wet air by a rise of temperature of 1° C. Direct observation shows that the number of nuclei caught in dust-free wet air at low barometer pressure is, *ceteris paribus*, greatly in excess of the number caught at high barometer. The comparison of the nucleation of dust-free air with the contemporaneous changes of atmospheric ionisation

shows no correspondence whatever; although the ions, while fewer in number, are larger in size than even the larger colloidal nuclei, and therefore capture much of the moisture. J. J. S.

783. Ship Propellers. H. Lorenz. (Zeitschr. Vereines Deutsch. Ing. 51. pp. 829-833, March 2, 1907.)—This paper gives a description of researches on the variation of the number of revolutions, and of the efficiency of propellers with the speed of propulsion. It is shown theoretically that for a resistance which is a quadratic function of the velocity, the angular velocity of the propeller is directly proportional to the velocity of propulsion. For the two propellers tested, ω , the angular velocity, and c , the velocity of propulsion, were found to be connected by the empirical formulæ $\omega = 5.48c + 0.198c^{.87}$ and $\omega = 5.22c + 0.869c^{.87}$, the speed of rotation varying in the first case from 167 to 805 r.p.m., and from 208 to 887 r.p.m. in the second case. As regards the efficiency, it is shown that the efficiency of a propeller is greater the greater the amount of water it drives out behind the ship. A complicated quadratic equation for the efficiency is arrived at, involving a number of constants, the angular velocity of the propeller, the velocity of propulsion, and the resistance. From the results of the experiments the author concludes that for the highest efficiency of the propellers, driving machinery giving only moderately quick rotation is required; and also that the employment of steam turbines is only justifiable when the economy of driving has to give place to other considerations. A. W.

784. Atomic Energy of Gases. G. Ensrud. (Zeitschr. Phys. Chem. 58. pp. 257-287, March 5, 1907.)—Regarding the atom as consisting of a core of great, and a mantle of small density, the author deduces the forces between atoms from the simple attraction law a/r^n . He assumes that there is an attractive force between the core and its own mantle as well as between the cores of different atoms, but that there is a force of repulsion between the mantles of different atoms. The attraction between a core and its mantle becomes zero when the core is in the centre of the mantle, and increases with the displacement from the centre. When the cores are eccentric, their position conditions a direction of greatest attraction between different cores, and so we get valency direction, and this idea can also be extended to atoms having more than one core. The author also calculates the distance between atoms, and the minimum angle of collision between atoms, and from the latter the atomic energy l from the expression $l = K \cos^2 \phi$, where K is the total energy of the molecule and ϕ the minimum collision angle. A. F.

785. Viscosity of Ice. B. Weinberg. (Ann. d. Physik, 22. 2. pp. 821-882, Feb. 5, 1907.)—In his former paper [Abstract No. 2188 (1905)] the author failed to establish a relation between the coefficient η of internal friction and the shearing rate $\dot{\alpha}$. This relation has a connection with the relaxation theory as developed by Maxwell and Schwedoff. It consists in a diminution of η with increasing $\dot{\alpha}$, and is marked by a double influence of temperature upon the rate of torsion ϕ' of the end of the cylinder. The rise of temperature θ reduces η , and so the speed ϕ' rises; this rise in turn reduces η , and ϕ' rises still further. These direct and indirect effects of the temperature may be separated by arranging the values of η not only by the temperature, but also by the final mean rates of shearing at neighbouring temperatures. To

judge from the value of η , the critical velocity of the ice-current in a glacier must be of the order of the velocity of light, so that such a current may be described as irrotational. The author adopts the formula—

$$\eta_0, \psi = \eta_0 \left(a - \frac{b}{a} \right) + \frac{c}{a}.$$

According to Schwedoff's relaxation theory—

$$\eta = NT + N\lambda/a',$$

where N is the modulus of rigidity, and λ the limit of elastic deformation. For Neva ice, the author finds the value 5.6×10^8 for λ at 0° , and 8.4×10^8 at -5° . For glacier ice the corresponding values are 10^8 and 0.8×10^8 . Small values of the rigidity, of the limit of elasticity, and the viscosity, and greater influence of the temperature must be regarded as an indication of the weakness of the limiting regions between the individual grains, and of a "wet" friction, produced by melting under pressure, in addition to the "dry" friction. That a "dry" internal friction is possible in ice is shown by its gradual shearing in directions normal to the optic axis, where local excess of pressure is quite excluded. This is confirmed by analogous phenomena in rock-salt, which, however, are not yet completely elucidated. E. E. F.

786. *Stationary Waves in Gaseous Streams.* T. Kármán. (Phys. Zeitschr. 8, pp. 209-211, April 1, 1907.)—Prandtl's theorem as to the possible existence of stationary waves in a gaseous stream, if with speed exceeding that of sound [see Abstract No. 8 (1905)], is deduced in a more general manner from Euler's equations with the condition that the disturbances are small as compared with the mean speed of the stream; it thus appears that vibrations are possible in the stream which are analogous to those of a membrane, the corresponding wave-lengths being $a(n^2 - 1)$ if the speed of the stream is n times that of sound, where a is a coefficient depending on the shape of the section of the stream and on the mode of the vibration. It further follows that waves in a cylindrical tube due to forced vibrations are periodic even at large distances from the source of disturbance if the air is moving with speed greater than that of sound, though Raleigh has shown that for less speeds they tend to become approximately plane. R. E. B.

787. *Viscosity of Liquids.* R. Ladenburg. (Ann. d. Physik, 22. 2, pp. 287-309, Feb. 5, 1907. Extract from Inaug. Dissertation, München.)—Tests Stokes's law of the fall of spheres in viscous liquids, and applies it in a corrected form to the determination of the influence of pressure and temperature upon viscosity. The law does not strictly apply to limited liquids, and the error amounts to several per cent. even when the ratio of the radius of the tube containing the liquid to the radius of the sphere is as high as 90. The author arrives at the following modified formula for the coefficient of viscosity k :—

$$k = \frac{2}{9} g R^2 \frac{s - \sigma}{a(1 + 2.4 R/r)},$$

where R is the radius of the falling sphere, r that of the tube, a its velocity, and s and σ the densities. There is another very small error due to the top and bottom, but this has not yet been calculated. Relative viscosities can be accurately determined by letting equal spheres fall through equal vessels, the

times of fall being proportional to the viscosities. The influence of temperature and pressure was found to be very large in a specimen of Venice turpentine of viscosity 1,800 c.g.s. units, amounting to an increase of 25 per cent. for a fall of temperature of 1°C ., and an increase of 100 per cent. for an increase of pressure of 100 atmos. On taking into account the thermal expansion and the compressibility, the author finds that the changes in the time of fall cannot be accounted for by mere changes of density, being much too large for that. Poiseuille's law is fulfilled by a very wide range of liquids, the deviation being less than 1 per cent. in a liquid having a viscosity a million times that of water. E. E. F.

788. *Capillarity*. H. Ollivier. (*Annal. Chim. Phys.* 10. pp. 229-288, Feb., and pp. 289-321, March, 1907.)—A description of researches on various properties of liquid drops, particularly small ones. The paper is divided into four sections. The first of these deals with the formation of small drops and the variations of their weight and shape. The method of photographing falling drops is discussed at some length. The second section treats of the influence of compressibility on the formation of drops; the third is concerned with the contact of water with smoked surfaces, and the last section gives an account of the direct and chronophotographic study of the reflection of drops. A small drop (G) was allowed to fall from a height of a few cm. on to a smoked metal plate inclined a little to the horizontal. The drop on rebounding divides into two drops, one of which (G') is about $\frac{1}{2}$ the diameter of the original drop, and rises, in general, higher than the orifice, in some cases even higher than the surface of the water in the reservoir. The principal part (G'') of the drop rises to a height of 1 or 2 cm., and is projected in the direction given by the law of reflection. The smaller part (G') is projected normally from the plate. Both drops vibrate energetically. This phenomenon is discussed, numerous diagrams and plates being given showing the form at different time-intervals. Photographs are also given of the reflection of drops of water by a water surface. The reflection at smoked surfaces is perfectly regular, the reflected drops describing the same trajectories time after time; consequently the phenomenon is well adapted for the study of the vibrations of small drops. The method also permits of the detection of small changes in the composition of liquids, and gives a very delicate dynamic method for measuring large surface tensions. A. W.

789. *Measurement of Surface Tension by the Bubble Method*. L. Ziobicki. (*Acad. Sci. Cracovie, Bull.* 7. pp. 497-506, July, 1906.)—The author has measured the surface tension of solutions of various colloids in water. The surface tension is increased by gelatine, glue, egg-albumen, dextrin, cherry resin; lowered, however, by gum arabic, starch, plum resin. The fall of surface-tension with rise of temperature is greater in the case of these solutions than in the case of water. The surface tension of colloidal solutions of metals was not found appreciably different from that of water. A. F.

790. *Meteorological Observations in Moscow, 1905*. E. Leyst. (*Soc. Imp. Nat. Moscou, Bull.* 4. pp. 808-852, 1905.)—The observations [see Abstract No. 487 (1904)] have been continued by A. A. Speransky (during his absence by the author) and assistants, disturbed in the last months by the riots and often at considerable danger to the observers. The air pressure was above normal in Feb. to June and in Aug. and Nov.; the mean deficiency of

—2.4 mm. in July is noteworthy. The diurnal amplitude of Jan. 29 was 29.9 mm., unprecedented for Moscow; between 11 and 12 a.m. the barometer fell by 2.4 mm., but this rate was surpassed in Feb., 1908, when a fall of 8.7 mm. was observed in one hour. Winter and spring were again, as in the last five years, too warm (Feb. by 8.2° C.), the last half of summer and Sept. too cold; spring commenced about three weeks too early, autumn was unusually long, June the hottest month; these features are very important. It did not thaw at all on 96 days, and there was frost on 160 days. Soil temperatures are determined at depths of 2.5, 1.6, 0.8, 0.4, 0.0 m.; the diurnal variation was still distinct at the depth of 0.4 m. The gradual heating of the soil occupied 24 months less time than the cooling. The sky was overclouded in March and April, and in Sept. to Dec. May received twice its usual rainfall, April hardly half; Sept. and Oct. received more rain than usual for the whole seven months Sept. to March, and these two months were decidedly cyclonal, and Sept. too warm, Oct. too cold. The snow thickness rose during Jan. and the first days of Feb. to 48 cm. Mock suns were seen once, pillars near the sun five times. H. B.

791. *Thermodynamics of the Atmosphere. V. Horizontal Convection in Cyclones and Anticyclones.* F. H. Bigelow. (Monthly Weather Rev. 84. pp. 562-572, Dec., 1906.)—Referring to his No. IV. of this series [Abstract No. 2008 (1906)], the author explains that the incessant turmoil of adjustment at all levels and in all latitudes is too complex to admit of being treated as an analytical unit, and he confines himself to more or less detached studies dealing with the horizontal circulation, the relation of thermodynamic gradients to hydrodynamic pressures in cyclones and anticyclones, and the horizontal interchange of heat energy. He then considers several simple cases, imagining two masses of air separated by a movable partition; in this consideration he follows M. Margules in his "Energie der Stürme," modifying the formulæ of Margules so as to meet non-adiabatic conditions. H. B.

792. *Solar and Lunar Coronæ (Höfe) in Russia.* E. Leyst. (Soc. Imp. Nat. Moscou, Bull. 1 and 2. pp. 1-109, 1906.)—The author draws attention to the prevailing ambiguity in the use of the international symbols for coronæ and halos adopted by the Meteorological Congress at Vienna in 1878. This ambiguity arises from the fact that, in the Report of the Congress, the symbols in question are designated by the German words "Hof" and "Ring" without further definition; and these two words are so constantly interchanged by German writers that much doubt has arisen among observers as to the meaning intended. "Höfe," or coronæ, are diffraction phenomena; they are small prismatic circles surrounding the sun or moon; their radius is variable, and seldom exceeds 6°, except in the extreme case of Bishop's Ring, where it was 15°. The symbol for a solar corona is a circle enclosing a vertical stroke; for a lunar corona a cup with a vertical stroke. "Ringe," or halos, are refraction appearances; the radius of a halo may have one of certain fixed values, the least of which is 22°. The order of the colours is opposite in the two phenomena, violet being inside in coronæ and outside in halos. A corona, however, has frequently a brownish-red inner border, easily distinguishable from spectrum red. The author has had to reject the English and German observations owing to the confusion in the use of the symbols. The French observers appear to take no cognisance of coronæ at all. Statistics collected throughout the Russian Empire are given, and the following conclusions drawn from their discussion: The coronæ exhibit annual and

secular variations, differing in details from the corresponding variations for halos, though resembling them in main features. Lunar coronæ are observed five times as frequently as solar. In the annual curve the maximum falls in spring, the minimum probably in July. In the daily curve the maximum seems to fall in the forenoon. The secular coronal curve shows more parallelism with rainbow frequency than with the halo curve. Coronæ are more frequent in continental than in coast districts. Halos are fainter phenomena than coronæ, requiring more darkness for their visibility. Throughout the vast extent of the Russian Empire the optical appearances show much the same general behaviour, though small modifications may arise from local conditions. The present paper completes a series of three; the first was on rainbows [Abstract No. 1035 (1902)], and the second, in 1903, on halos. A. E.

793. *Thermodynamics of the Atmosphere. IX. Meteorological Conditions associated with the Cottage City Waterspout.* F. H. Bigelow. (Monthly Weather Rev. 34. pp. 511-517, Nov., 1906.)—The author calculates the maximum velocity in metres which will sustain a freely falling body (raindrops) in the atmosphere from the formula $w = 7.508 \sqrt{(T/B) \cdot (D\rho_w) \cdot (1/k)}$, where T is the absolute temperature, B the barometric pressure in cm., D , the diam. of the body in cm., ρ_w its density, and k the friction factor ranging from 1.0 to 1.9; in the tables the three bracketed terms under the root are separated. He then examines Lenard's experiments on raindrops [Meteorolog. Zeitschr. June, 1904], with which he agrees on the whole, and computes the probable vertical velocity in clouds, which rarely reaches 15 m./sec., and does not exceed that value. Returning then to the Cottage City Waterspout [see Abstract No. 190 (1907)], he computes the approximate position of the isotherms and isobars of the three hours, 10 a.m., 1 p.m., and 4 p.m., of Aug. 19, 1896, and passes to a discussion of the theories on the formation of hail, referring particularly to the orbital theory of Ferrel, the upward-current theory of P. Schreiber and others, and the electrical attraction theory of Trabert and F. W. Very. He himself advocates a stratification theory. If there were no repetition of the layers, the hailstone would consist of a centre of snow belonging to the δ stage in the cloud; a mixed layer of snow and ice, representing the undercooled crystals of the γ stage; and clear ice, representing the gradual cooling ice of the β stage in contact with a cold nucleus. If there are repetitions, these stages are mixed in the internal circulation of the cloud. Hail is formed at the rear of the rising column of warm air, at the place of marked changes in the isotherms when the barometer is beginning to rise rapidly and the wind shifts from south to north-west. This is the locus of two counter-currents of air at very different temperatures; the warm air tends to rise and to interpenetrate the cold air, and the boundary between the β and the δ stages, or the course of the γ stage, is several times folded upon itself in a vertical direction. H. B.

794. *Variations of Temperature with Altitude.* C. H. McLeod and H. T. Barnes. (Monthly Weather Rev. 34. pp. 505-510, Nov., 1906.)—From a close study of the relative variations of the records at the McGill College and at the mountain station of Mount Royal, 8,800 ft. distant horizontally [see Abstract No. 21 (1906)], the following conclusions have been drawn: (1) Steady normal negative difference (colder on the mountain) indicates continued temperature conditions at the lower station. (2) Increasing negative difference indicates that the temperature conditions will grow colder at the

lower level. (3) Decreasing negative difference indicates that the temperature will rise at the observatory. (4) A positive difference indicates a rise of temperature at the observatory. A positive wave on the trace has been observed to accompany a heavy fall of snow, as the rapid crystallisation in the upper atmosphere had resulted in a sensible evolution of heat. Evidence is adduced showing that advance warnings of changes of temperature are frequently available, varying from 5 to 19 hours, so that the method gives promise of considerable practical utility. C. P. B.

795. *Harmonic Analysis of the Diurnal Barometric Curve, at Washington, D.C.* W. J. Bennett. (Monthly Weather Rev. 34, pp. 528-580, Nov., 1906.)—Averages of the hourly barometric readings at Washington for the years 1891-1904, show a diurnal variation of 0.0687 in., with a maximum at 10 a.m., a minimum at 4 p.m., a secondary maximum at 11 p.m., and a secondary minimum at 8 a.m. (difference 0.0078 in.). Similar phenomena are found elsewhere, but in oceanic climates the two maxima and the two minima are nearly equal. The harmonic analysis by the method of F. N. Cole shows that the first component is greatest in early summer and least in early winter, the difference being 0.0109 in., and that this variation agrees closely with the daily temperature change. But as the temperature change from lowest to highest is twice as rapid as that from highest to lowest, its effect on the barometer is partly taken up by the second component whose maxima and minima lie only 6 hours (not 12) apart. The second component has its greatest amplitude in winter and its least in summer; the variation is inversely as that of the first component, and its amplitude about half as large, 0.0056 in. There should be a lunar tidal effect (in addition to the solar) on the barometer, and the barograph curves of Charlotte, N.C., have been examined for this purpose. The gravitational explanation of the second component proves unsatisfactory, however, and radiation from the upper strata or vertical movements of the air seem to be concerned. The amplitude of the third component shows a double variation, great in winter and summer, small in spring and autumn; but the component changes its phase at the equinoxes, so that there is really a single variation with a range of 0.0085 in. in winter and of 0.0023 in. in summer; this seems to be connected with the annual movement of the sun in latitude. The fourth component also has its greatest amplitude of 0.0042 in. in the winter, and its least, of 0.0004 in., in summer; it can hardly be due to accidental fluctuations, but no physical cause can so far be assigned for it. H. B.

796. *Weather Reports of the Meteorological Office.* (Nature, 75, pp. 488-490, March 21, 1907.)—The Danish Government and the Great Northern Telegraph Co. having laid cables to the Færoe and to Iceland, meteorological reports have been received in London from Thorshavn (Færoe) and Seydisfjord (east coast of Iceland) since Oct., 1906, and from Reykjavik with messages from Blönduos and Akureyri (Iceland) since Feb. 15, 1907. Adam Paulsen, director of the Danish Institute, to whom this achievement is mainly due, died in Aug., 1906. The service is paid out of the Treasury grant of the Meteorological Office, which further receives occasional reports by radiotelegraphy from the ships of the Navy. The new daily weather charts of the Office take in Gibraltar and Iceland, also the Azores, from which Chaves and the Portuguese Government send information. The specimens of the daily barometer, wind, and sea-charts reproduced show the development of the storm which wrecked the *Berlin* on Feb. 21. The new weekly reports

include grass and ground temperatures; upper-air observations made by W. H. Dines at Pyrtton Hill, Oxon., C. J. P. Cave at Ditchans Park, S. H. R. Salmon at Brighton, and J. E. Petavel at Glossop Moor; sea temperatures from coastguard stations and elsewhere; and general remarks on warmth, rainfall, and sunshine duration during the week in the twelve districts of the British Isles. The paper explains how the rainfall averages are obtained. At present three bodies publish observations: the Meteorological Office, and the Royal and Scottish Meteorological Societies. H. R. Mill, director of the British Rainfall Organisation, will co-operate with the Office. The daily weather report is sent to any one free of charge on payment of postage and wrappers. H. B.

797. *Character of the Intertropical Atmospheric Circulation.* L. Teisserenc de Bort and L. Rotch. (Comptes Rendus, 144. pp. 772-774, April 8, 1907.)—General conclusions drawn from the results of the cruises of the *Olaria* [see Abstract No. 191 (1907)]. The trade winds from W. and E. do not as a rule reach heights of more than a few hundred m., in which the temperature-fall is rapid. Then follows a stratum of temperature inversion with winds of feeble intensity; this stratum, already described by Hergesell, extends beyond the equator to the islands of Ascension, and Humboldt's temperature parabola, with inversion at about 800 m., is confirmed. Higher up follow afterwards different winds, from NE., then from the S., and the counter-trades; the latter begin near the Tropics at 2,500 m., at Teneriffe a few hundred m. higher up, near the equator at 2,000 m. Near the Azores the counter-trade blows from W. In the equatorial regions easterly winds predominate, and the counter-trades mark the effect of the earth's rotation distinctly. Near Ascension the vertical sequence is: Trade winds from SE., diverse winds from SW., &c., counter-trade from N. H. B.

798. *Sea Current Measurements at Various Depths in the North Sea.* C. H. Wind, A. F. H. Dalhuisen, and W. E. Ringer. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 616-628, Feb. 6, 1907. Proc., 9. pp. 566-578, Feb. 21, 1907.)—Observations were started in 1904 by A. M. van Rosendaal and also J. P. van der Stok on behalf of the Rijksinstituut voor het Onderzoek der Zee on the lightship *Haaks* and the research steamer *Wodan*. Current meters of Nansen, Pettersson, and Ekman were used; the Nansen type did not prove suitable for the strong tidal currents (60 to 100 cm./sec.), the other two types agreed fairly. The more recent observations have been made by Dalhuisen with Ekman meters. The tidal curves of the older and more recent observations show about the same shapes. The amplitudes are less near the bottom than near the surface; the phases change with the depth. The residual currents are by no means constant, and there is little agreement between the authors' currents, tabulated for the depth of 5 m., and the surface currents of the British Admiralty charts. H. B.

799. *Theory of Dislocations in the Earth's Crust.* L. De Marchi. (Accad. Lincei, Atti, 16. pp. 884-895, March 17, 1907.)—The object of this communication is to show that the elastic displacements produced in the earth's crust by the continual transport of matter from the zones of degradation (Continental) to the zones of sedimentary deposit on the bed of the ocean are sufficient to explain, according to the theory of elasticity, the general form of the earth's surface and the fundamental character of the ridges or cor-

rugations which we know as mountain chains. The earth's crust has been supposed to be homogeneous to a certain depth, isotropic, and perfectly elastic, so that the coefficients of elasticity may be regarded as constant. The measurements made by Nagaoka and Kusakabe show, however, that most rocks do not obey Hooke's law even for small flexures and torsions, and some tend to behave as viscous substances like ice. The analytical treatment is founded on the works of Cerruti and Boussinesq and Cesàro's Introduction to the mathematical theory of elasticity (Torino Bocca, 1894, chap. xiv., pp. 115 *et seq.*). He considers first the pressure on a plane belt, so long that as regards the effects produced at great distances from the ends, it may be regarded as of infinite length. The plane of the belt is that of xy . The axis of z is perpendicular to it, and the displacement in z , denoted by w , is in direction of z diminishing. The axis of x is at right angles to the centre line of the belt, and the displacement in x is denoted by u . The quantities w and u are expressed by the general equations of the theory of elasticity in terms of the pressure p in direction z per unit of length of the belt, and A and B the two constants of isotropy. The writer determines from the conditions of the problem the two arbitrary constants w_0 and u_0 contained in the general equations. Thus he obtains expressions for the displacements in z and x respectively corresponding to pressure along a single line parallel to the belt, also expressions for the tensions in three directions in the plane of xz , due to equal and opposite vertical pressures on two lines parallel to the belt. In this case the tensions are proved to be independent of the elastic properties of the body, denoted by A and B , and are therefore transmitted in a heterogeneous body, as in a homogeneous body, without discontinuity at the surface of contact of different substances. This, he says, has been already noticed by Boussinesq. Assuming p to be 500 atmos., he calculates numerical values for the three tensions. He then proceeds to find numerical values for two cases: (1) in which the pressure is at points along a single line parallel to the belt and at distance c from it; (2) in which equal and opposite pressures are exerted at points along two such lines, one the centre line of the belt and the other at unit distance from it. The results obtained from (1) are as follows: That there will be a superficial cavity, but within a circle described about the origin with radius c there will be a condensation equal to $2B/A$ of the cavity. For the case $A = 4B$, or $\mu = \frac{1}{2}$, if the cavity be filled with water, taken at half the mean density of the surface rocks, the condensation will exactly balance the deficiency, so that the surface cavity has no effect on gravity, or the level surface remains plane. From consideration of case (2), that of two lines, he obtains the results: There will be defect of matter on one side and excess on the other side of the centre line or axis, with corresponding condensation or dilatation below the surface. The displacement in x is zero at all superficial points outside of the space between the two lines, but within that space it is constant and equal to $A/2(A - B)$. That there is a general motion of translation from the side subject to positive pressure to that subject to negative pressure or traction. The displacement in x is also zero at all points on a certain curve symmetrical with regard to the centre line and extending indefinitely from the axis of x without touching that axis. Whence it appears that the point A in which that curve cuts the centre line is a centre of rotation round an axis parallel to z . Assuming $p = 7.8$ kg./mm.², i.e., about 700 atmos., he gets, for given c , the following results: (a) The fall in the zone of pressure and the rise in the zone of degradation are about 1,500 m. (b) The superficial transport of matter between the zones extends to about 300 m. (c) The horizontal displacement which near the surface is negative—

that is from the rising to the falling strata, is in every horizontal plane a maximum along the intersection of that plane with the plane through the axis of z half-way between the lines of pressure and of traction, but has two minor maxima outside of the two zones of pressure and elevation, one, at somewhat greater distance, under the cavity, the other under the elevated portions. (d) The same horizontal displacement in the region between the zones diminishes as the depth increases in the region outside of the zones; it increases with the depth, being zero at the surface. (e) Under the line of pressure there is a synclinal, under that of elevation, an anticlinal, configuration. (f) The centre of rotation is at distance 1,000 km. between the zones, at depth about 280 km. A further communication is promised. S. H. B.

800. *San Francisco Earthquake Records at Moscow.* E. Leyst. (Soc. Imp. Nat. Moscou, Bull. 1 and 2. pp. 185-190, 1906.)—The two Bosch-Omori seismographs, mounted on pillars going 4.5 m. down to the sand, the one in the meridian, the other east-west, have been in operation since 1902. The local times of the San Francisco records (not reproduced) are:—

	N.-S. Component.	E.-W. Component.
Preliminary tremors begin ...	14 h. 28 min.	14 h. 51 min.
Main " " " ...	14 " 57 "	14 " 54 "
Maximum amplitude	15 " 0 "	14 " 57 "
Main tremors stop	15 " 12 "	15 " 4 "

The lateness of the first record of the E.-W. seismograph at Moscow was probably accidental; the chief tremors threw both instruments off their scale, the maximum observable amplitude being 150 mm. The author tabulates the times of the records observed at other European stations (not including the Western States) and points out that the main phase travelled to Trieste in 28.5 min., to Pola in 41 min. (although near Trieste), to Moscow in 42.5 min., to Tiflis in 46 min. The mean velocities of propagation of the main phase would be: To Strassburg 4.5 km./sec., to the Austrian stations 4.4, to Moscow 8.8, to Tiflis 4.1 km./sec. The mean velocity of the preliminary tremor was 10.6 km./sec. H. B.

801. *Comparison of the Faults in the three Earthquakes of Mino-Owari, Formosa, and San Francisco.* F. Omori. (Physico-Mathematical Soc., Tokyo, Proc. 4. 2. pp. 80-82, March, 1907.)—The three earthquakes of Mino-Owari (Central Japan, Oct. 28, 1891), Kagi (Formosa, March 17, 1906), and San Francisco (April 18, 1906) were each accompanied by the formation of remarkable geological faults, of total lengths 100, 50, 480 km. respectively. In the former two cases, the dislocations were at right angles to the axis of the mainland; the San Francisco fault was longitudinal. In all the three cases, however, the formation of the fault seems to have been due, not to a caving-in, but to shearing stresses. H. B.

802. *Seismic Constants of the Balkan Earthquake of April 4, 1904.* E. Oddone. (Comptes Rendus, 144. pp. 662-664, March 18, and pp. 722-724, April 2, 1907.)—According to J. Michailovitch and S. Watzoff, the earthquake which did a great deal of damage in Macedonia, Bulgaria, and Servia, consisted of three main shocks, at 10 h. 4, 9, and 27 min. (Greenwich M.T.), followed by aftershocks at 10 h. 32, 10 h. 37, to 11 h. 37 min.—10 shocks

altogether. The author calculates the $T=f(\Delta)$, the times T_1 and T_2 required by the first and second preliminary vibrations to arrive at the distance Δ from the epicentre, by the formulæ of Milne, Laska, and Benndorf, which had been verified for maximum distances of 150° or about 16 megametres. He finds $T_1=84$ min. for $\Delta=40$ megam.; this was the time-interval between the first and fifth shocks, and the same time-interval of 83 min. occurred between the third and sixth, and the sixth and tenth shocks. In the second paper the author points out that the seventh and ninth shock occurred 64 min. after the first and third respectively, and that therefore the waves reflected at the antipode took 88 and 64 min. to traverse the earth's diameter twice. There are other periodicities, the simple period of 5 or 6 min. and its multiples, and it would appear that a reflected wave can, on its return, produce a second shock. It is interesting that the seismic longitudinal waves travel along the terrestrial radius r in the same time of 8 min. which light occupies in passing from the sun to the earth along the radius of the earth's orbit R , so that, if v and V are the respective velocities of the waves, $v=Vr/R$. Solar activity as evidenced by spots and protuberances frequently appears simultaneously at the two extremities of a solar diameter. H. B.

803. *Temperature of Mars.* P. Lowell. (Amer. Acad., Proc. 42 No. 25, pp. 651-667, March, 1907.)—The chief obstacle to crediting Mars with the possibility of life has hitherto lain in accounting for sufficient heat on the surface of the planet. Determinations have been based only on consideration of distance from the sun, and apparently some investigators have calculated the temperature either by Dulong and Petit's law, which would give for the mean temperature -96°F. , or by Newton's assumption that a body radiates heat in direct proportion to its temperature, which would give -286°F. ; for they have believed that the polar caps may be composed of solid carbonic acid, which freezes only at -109°F. A better determination has recently been made by Moulton taking Stefan's law of radiation, that of the fourth power of the temperature, which gives -88°F. The author, however, points out that distance is but one of several factors that must be taken into account, and proceeds to consider the proportion of radiant energy reflected, absorbed, and transmitted, both by the air and by the actual surface of the planet; the relation borne by the visible and invisible rays to the subject; the blanketing effect of the atmosphere, &c. It might be supposed that, owing to the thinness of the Martian air relatively to the earth's, a larger fraction of solar heat would be received by the planet's surface. But the very rarity of the air joined to the lesser gravity at the surface of Mars would lower the boiling-point of water to something like 110°F. The sublimation at lower temperatures would be correspondingly increased. Hence the amount of water vapour in the Martian air must on that score be relatively greater than our own. Further, the planet would part, *ceteris paribus*, with its lighter gases the quickest, and this gives reason to think that both water vapour and CO_2 are present in relatively greater quantity than in our air. The absorption due to their presence will lessen the heat received at the surface of Mars, but it is to be noted that what is thus lost in reception furthers retention. About 50 per cent. of the earth's surface is covered by cloud which only transmits 20 per cent. of heat received, while Mars is almost free from cloud. Taking this into consideration the author calculates the mean annual temperature of Mars from that of the earth by Stefan's law,

A first result based on comparison of albedoes gives 72°F . or 22°C . as the mean annual temperature, on Mars if heat were retained there as well as on earth, which is probably far from being the case. He also attempts to calculate the density of the Martian air from its albedo, taking the density as proportional to the brilliancy, on the ground that the brilliancy is largely due to dust, and the denser the air the more dust it will buoy up. The author's final results are as follows: Mean temperature, 48°F . or 9°C .; boiling-point of water, 111°F . or 44°C .; amount of air per unit surface, 177 mm. ($\frac{1}{3}$ of earth's); density of air at surface, 88 mm. ($\frac{1}{10}$ of earth's). *Albedo of Venus.*—The author regards the high albedo of Venus, given by Müller as 0.92, as due to the presence of dust. The albedo of cloud being only 0.72 can hardly account for it. The planet's markings appear to him not obscured by cloud, but seen as through a veil. His observations confirm Schiaparelli's view that Venus keeps the same face to the sun, and this would cause convection currents and absence of moisture on the sunlit half. Dry winds blowing over a Sahara would be laden with dust, and Very's investigations find dust to be the chief cause of reflection in our own air. A. E.

804. *Characteristic Phenomena of Sun-spot Spectra.* G. E. Hale and W. S. Adams. (Astrophys. Journ. 25. pp. 75-94, March, 1907. Contribution from the Solar Observatory, No. 15.)—In a previous note [Abstract No. 2001 (1906)] the authors showed that the lines strengthened in the spectra of sun-spots are in general strengthened in the laboratory when the vapour producing them is reduced in temperature. The present paper furnishes additional evidence that most of the characteristic phenomena of sun-spot spectra are due to a reduction in temperature of the spot vapours below that of the reversing layer. Evidence is given showing the presence of titanium flutings in the spot spectrum, and a photograph included with the paper indicates the flutings at 7054.6, 7088.0, 7125.9. In detailed tables the comparisons of spot and arc-flame spectra are given, the corresponding lines in the disc spectrum being also noted where they occur. Out of a total of 284 spot lines, 152, or 65 per cent, were coincident with titanium lines. The titanium flutings were not present in the spectrum of the disc, from which it is concluded that the temperature of the reversing layer is normally too high to admit of the presence of the band spectrum of Ti. Investigation of the motion of the vapours in the line of sight has also been carried on, and it is concluded that very little radial motion can be detected; in the few cases where it was suspected it was *downward*, and only amounted to about 0.2 km. per sec. Dealing with the temperature of spot vapours, the presence of the flutings of titanium, which are absent from the solar spectrum, indicates that the vapours of sun-spots and third-type stars are cooler than the corresponding vapours in the solar reversing layer. C. P. B.

805. *Spectrum and Radial Velocity of Mira.* J. S. Plaskett. (Roy. Astronom. Soc., Canada, Journ., Vol. 1. No. 1. Nature, 75. p. 518, March 28, 1907. Abstract.)—Results of spectrographic work on the variable α Ceti during the last maximum with a three-prism Brashear universal spectroscope, giving a linear dispersion at H γ of 18.6 tenth-metres per mm., with a resolving power of 40,000. For the absorption lines a radial velocity of 85.6 km. reduced to the sun, was obtained. The velocity determined from the bright hydrogen lines is about 15 km. less. The spectrograms show that Ti is represented in the spectrum, and that the Mg-line $\lambda 4571$, which was bright in 1902, was recently seen as an absorption line. H β is a fairly strong, bright line, but H α cannot be detected. C. P. B.

REFERENCES.

806. *Sankey's Alternate Bending Testing Machine*. (Engineering, 83, p. 209, Feb. 15, 1907.)—Describes the machine referred to in Abstract No. 263 (1906), with the addition of illustrations and specimen records obtained from steel samples.

F. R.

807. *Theory of Steelyard*. F. Malý. (Zeitschr. Instrumentenk., Beih. 6, pp. 53-55, March 15, 1907.)—Discusses the theory of the graduation and of the stability of the steelyard.

A. W.

808. *Manostats*. R. Stevenson. (Journ. Phys. Chem. 11, pp. 107-118, Feb., 1907.)—Manostats are classified by the author according as regulation is effected: (1) By use of a continuous current of gas, or vapour; (2) by an intermittent or oscillatory supply of gas; or (3) by means of compensatory volume or temperature changes within the system. Types belonging to each class are outlined.

L. H. W.

809. *Bending of Straight Beam*. H. Zimmermann. (Preuss. Akad. Wiss., Berlin, Sitz. Ber. 12, pp. 235-244, 1907.)—The problems here solved are the same as those mentioned in Abstract No. 3 (1906), except that the beam is supported at a certain number of points only, instead of continuously; the differential equations involved are of the second order only, whereas they are of the fourth order in the case of the continuous supports.

F. R.

810. *New Investigations on Reinforced Concrete Slabs*. Ramisch. (Verein z. Beförd. des Gewerbfleißes, Verh. No. 7, pp. 338-350, Sept., 1906, and No. 1, pp. 44-46, Jan., 1907.)—A mathematical treatment.

811. *Strength and Elastic Equilibrium of Wire-wound Tubes*. A. Jacob. (Comptes Rendus, 144, pp. 121-123, Jan. 21, 1907. Extract.)—The author has considered the calculations for the wire winding of gun tubes, from the point of view of permissible strains, instead of stresses as is usually done. The detailed results are not given in the abstract, but the report gives solutions of the problems of the stresses as functions of the winding tension in the wire, and of obtaining the best combination of high stresses in the tube with low tension in the wire.

F. R.

812. *Exact Measurement*. R. T. Glazebrook. (Inst. Elect. Engin., Journ. 38, pp. 4-23, Feb., 1907. Presidential Address.)

813. *Velocity of Hot Gases*. R. Vamvera and F. Schraml. (Stahl u. Eisen, 27, pp. 334-339, March 6, 1907.)—In this paper the authors show that the Pitot tube is well adapted for the measurement of the velocity of currents of hot gas. They also give theory relating to the effect of rotating the Pitot tube about the long branch which passes through the side of the tube along which the gas is flowing. They show that different constants are required for different positions. [See Abstract No. 376 (1907).]

A. W.

814. *Attraction of Ellipsoidal Shells and of Solid Ellipsoids at External and Internal Points*. A. Gray. (Phil. Mag. 13, pp. 385-413, April, 1907. From Roy. Phil. Soc., Glasgow, Proc. 1906.)—A complete solution is given of the problem of the shell and the ellipsoid.

815. *Rothsay Rainfall and the Sun-spot Cycle*. A. B. MacDowall. (Nature, 75, p. 488, March 21, 1907.)—Referring to Buchan, the author points out that the records of Rothsay, Bute, which go back in an uninterrupted series to 1800, clearly show the close relation between maximum rainfall and maximum sun-spot activity in a cycle of eleven years. He gives rainfall and sun-spot curves for the month of July, taking the means of five consecutive years, from 1800 to 1906.

H. B.

LIGHT.

816. *Refractive Index and Dispersion with the Interferometer.* C. A. Proctor. (Phys. Rev. 24. pp. 195-201, Feb., 1907.)—A simple arrangement is described for producing, from ordinary laboratory apparatus, the slow rotation of the glass plate under test on an interferometer, the index of refraction and dispersion being calculated in the usual way. Defects due to want of plane-parallelism can be allowed for, and the method may be applied to samples varying in thickness from 1.5 mm. up. Results are given for two glasses of thickness about 1.7 mm. and 8.7 mm. G. E. A.

817. *Nature of Optical Images.* A. B. Porter. (Phys. Rev. 24. pp. 808-806, March, 1907.)—For educative purposes an experiment is described which shows the relation between interference and image formation. The experiment consists in passing a parallel beam of monochromatic light through a coarsely ruled, black-line, diffraction grating, and then through a convex lens. A system of sharply defined interference fringes is formed, which can be seen by aid of an eyepiece or intercepted on a screen, at any point over a considerable range along the axis. The geometrical image is visually indistinguishable from any other transverse section of the fringe system, and in this case is merely that section in which the geometrical condition of similarity to the object is satisfied. Particulars of the best arrangement of the experiment are given. G. E. A.

818. *Pleochroic Halos.* J. Joly. (Phil. Mag. 13. pp. 381-383, March, with Plate facing p. 560, April, 1907.)—Crystals of zircon in biotite are invariably surrounded by an area showing strong pleochroism. The well-developed halo appears never to have a greater radius than 0.05 mm.; smaller halos are frequent. It is thought that this is due to the radio-active properties of zircon. It is remarkable that the radius is about what would be expected if the appearance is due to the α -rays of radium, using Rutherford's data as to the absorption. R. S. W.

819. *Some Details of the Spectroheliograph.* H. Deslandres. (Comptes Rendus, 144. pp. 541-546, March 11, 1907.)—Further details are given respecting the two supplementary spectra photographed, with the extremities of the slit, in a corner of each solar plate as a check on adjustment, &c. [see Abstract No. 593 (1907)]. The information is called forth by some remarks made by Millochau [Abstract No. 622 (1907)], who apparently supposed the idea to be new. Deslandres and d'Azambuja have rejected the use of diffuse light, and have employed the image of the sun itself, displaced at the first slit, for the two control spectra. Spectral displacements due to solar rotation are in this way taken account of. The control, however, furnished by exposures made at the ends of the second slit is insufficient; it does not apply to the central portion of the slit used for the monochromatic image, and the ends of the slit are generally of less accurate workmanship than the centre. Hence Deslandres is now turning his attention to a construction which will enable the central portion of the slit to be used for the control exposures. The chief

difficulty lies in the fact that the curvature of the spectrum lines varies from line to line. In the new device—which is applicable only to ordinary slits; not to slits on silver film—both jaws are opened automatically by exactly equal amounts, by means of two identical cams. It is then easy to judge whether a line is in the middle of the slit; and, further, the small portion of the spectrum of the solar disc passing through the widened slit is photographed on the plate margin. Each jaw of the slit is pressed by a spring, and one cam is in contact with a micrometer screw. As regards visual control, for the more refrangible rays Soret's fluorescent screen is recommended. It renders visible the whole ultra-violet and violet spectrum, while the liquid aniline-violet screen suggested by Millochau only reveals as far as $\lambda 3870$. The use at the first slit of a liquid screen with glass walls is dangerous on account of the heat developed.

820. *Radiation from selectively reflecting Bodies.* W. W. Coblentz. (Phys. Rev. 24. pp. 807-820, March, 1907.)—In his "Investigations of Infra-red Spectra," Parts III. and IV. [Carnegie Inst. of Washington, Dec., 1906, and Abstract No. 587 (1906)], the author showed that all the silicates examined have strong bands of selective reflection in the spectral region 8μ to 10μ , and discussed the effect upon a reflecting surface like the moon. The purpose of the present paper is to summarise the present data, and to discuss some further points. The paper opens with remarks on the effective temperatures of the sun and moon. Since with each new determination the solar constant is being reduced, 2.1 calories is regarded as a more probable value than 2.5, the value used by Poynting [Abstract No. 1082 (1904)] in determining the temperatures. In the case of the moon a further deduction is made for conduction inwards. On p. 814 the author assumes $5,900^\circ$ abs. and 850° abs. for the effective temperatures of the sun and moon respectively. In order to explain the fact that Very found appreciable radiation from the moon during total eclipse, the author roughly calculates the temperature decadence curves for three different values of lunar emissivity. The curves show that fall of temperature is not coincident with fall of illumination unless the moon's emissivity is about that of iron oxide (0.8 of a "black body"). Next, the selective reflection of silicates is compared with reflection from the moon, by the aid of curves, for the spectral region 4μ to 12μ . On the usual assumption that the crusts of the earth and moon are of the same silicate constitution, they "may be considered selectively reflecting surfaces, with a band of metallic reflection from 8.5μ to 10μ . Hence, in the region of the spectrum from 4μ to 7μ , only 3 to 5 per cent. of the radiation from the sun would be reflected from the moon, under the best surface conditions (diffuse reflection), while in the region from 8μ to 10μ the reflecting power would rise to 50 or even 80 per cent." The author emphasises the point that a matt surface can be selectively reflecting, as misunderstanding has been caused by overlooking this fact. A silicate, such as quartz, which reflects like a metal for $\lambda = 8.5\mu$ and 9.0μ , and like a transparent medium for all other wave-lengths, must still be selective for diffuse reflection. The reflected energy from the moon in all regions except 8μ to 10μ will consist of two parts, viz., that reflected from the outer surface and that due to internal reflection. But from 8μ to 10μ almost all the observed energy will be due to reflection from the outer surface, and there will be little or none due to internal reflection. Hence, to use the reflected energy spectrum of the moon from 0.5μ to 4μ as a means of estimating the amount of reflected energy at 8μ to 10μ is not a fair test. The main problem faced by the author is the calculation of the relative intensities

of the energy emitted and reflected at 8μ to 10μ . Langley observed radiation from the moon and also from the sun in the region 8μ to 10μ , and we do not know how much of the solar radiation is superposed upon the lunar, owing to the moon being selectively reflecting in this region. In the region 5μ to 8μ almost all the energy is absorbed by the water vapour in the earth's atmosphere. For visible rays the moon's reflecting power, according to Langley, is only 1/500,000 full sunlight. At 0μ the reflecting power may be ten times greater. The author makes an attempt to solve the problem by the aid of Planck's formula for distribution of energy in the spectrum of a full radiator, and finds the ratio of the emissive power of the moon to that of the sun to be 0.000316, which is sixteen times the solar energy reflected from the moon. This result, he says, involves too many assumptions to be of much value. Bolometric comparisons at high altitudes will be of greater service, and Very's suggestion of searching for a solar image in the lunar image with a delicate heat-measuring instrument is supported [see Abstract No. 196 (1907)]. In the last section it is shown that a selectively reflecting body like quartz will be a partial radiator, and that if its radiation curve be compared with that of a full radiator, there will be minima of emission in the region of 8.5μ and 9.08μ . The curves given for carborundum SiC, and quartz, markedly illustrate the effect of selective reflection upon emission. The discussion of the moon's radiation is thus further complicated by the presence of emission minima from 8.5μ to 9.8μ . Some remarks are added on the possible effects of irregular emissive power on sun-spot radiation, since the sun, as well as the moon, does not radiate like a "black body." [Erratum.—Abstract No. 196 (1907), line 4: for "reflecting only diffusely" read "with reflecting power practically zero."] A. E.

821. *Intensification of Contrast by Polariscopes.* F. Biske. (Mem. dell' Soc. Spettroscop. Ital. Vol. 86. No. 2. Feb., 1907. Nature, 75. p. 498, March 21, 1907. Abstract.)—Under certain atmospheric conditions and relative positions of celestial bodies it is possible to polarise the light received from them, so that the ratio of the amount of light from the body to that of the sky is increased, thereby rendering the observed object more easily visible. It is suggested that by this means the observation of the corona whilst the sun is not eclipsed may be accomplished, and that comets may be observed more easily. C. P. B.

822. *Transformation of Radiation.* B. Davis. (Phys. Rev. 24. pp. 181-190, Feb., 1907.)—A plane-polarised beam of light is generally considered to consist of a train of waves in which the electrical component alternates in sign but remains in the same plane perpendicular to the wave-front. As the wave passes through a surface, a point on the surface would be subject to an alternating field of force. It would be a matter of great importance to rectify the small currents that are set up in a conducting surface by such alternating fields of force. The detection of these currents would not only confirm the electromagnetic theory of radiation, but would furnish a direct method for distinguishing the electric and magnetic components of the wave. The late A. Bartoli carried out experiments which he thought succeeded in rectifying the currents in question. [See Abstract No. 1164 (1904).] The present author, however, with a modified apparatus and very sensitive galvanometer failed to detect a direct current from such an effect, and so considers the Bartoli phenomenon not yet established. E. H. B.

828; *Origin of Spectral Series*. W. Ritz. (Comptes Rendus, 144, pp. 684-686, March 18, 1907.)—The frequencies of the ordinary spectrum of hydrogen, and of the new spectrum discovered by Pickering in certain stars, are given by the formulæ—

$$(1) \quad \nu = N \left(\frac{1}{4} - \frac{1}{m^2} \right), \quad \nu = N \left[\frac{1}{4} - \frac{1}{(m-\frac{1}{2})^2} \right], \quad (m=3, 4, 5, \dots);$$

where ν is the frequency, and N a constant. Such systems of vibrations are distinguished essentially from all those with which we are familiar by the existence of a frequency limit for $m=\infty$, and by the absence of the term in ν^2 due to the acceleration. The same anomalies are found in the other spectra studied by Rydberg, Kayser, and Runge. The author describes a physical conception of a system which will give rise to vibrations of this type. Suppose A and B to be two fixed points connected to C , the middle point of the line AB , by inextensible strings; the length of the strings differing but slightly from $AC=BC$. Let the strings rotate about AB , either in the same or opposite directions, with uniform angular velocity ω ; and let AB be taken as axis of x . Each string will assume the form of a plane sinusoid given by the equation $\frac{T d^2 \phi}{ds^2} + \omega^2 \mu \phi = 0$, T being the tension, μ the mass per unit length, and ϕ the distance of an element from the axis. Hence the tensions in AC, BC , are given by—

$$T_A = \frac{\omega^2 \mu}{c^2 \pi^2} \frac{1}{m^2} \quad \text{or} \quad \frac{\omega^2 \mu}{c^2 \pi^2} \frac{1}{(m-\frac{1}{2})^2}, \quad T_B = \frac{\omega^2 \mu}{c^2 \pi^2} \frac{1}{n^2}, \quad \&c. \\ (m, n=1, 2, 3, \dots).$$

Therefore the point C is acted on by a force, parallel to the axis, nearly equal to $T_A - T_B$, or to—

$$\frac{\omega^2 \mu}{c^2 \pi^2} \left(\frac{1}{n^2} - \frac{1}{m^2} \right) \quad \text{or} \quad \frac{\omega^2 \mu}{c^2 \pi^2} \left(\frac{1}{n^2} - \frac{1}{(m-\frac{1}{2})^2} \right) \quad (n, m=1, 2, 3, \dots),$$

tending to displace it. Next consider a moving corpuscle of mass M and charge e in a magnetic field H parallel to the axis of x . The resultant of the other forces is supposed to be zero or parallel to H . The projection of the motion on a plane perpendicular to the axis is shown to be a circle, the time of revolution T , or rather the frequency $\nu = 2\pi/T$, being given by $\pm \nu = eH/Mc$. Now suppose that the strings AC, CB form part of an electric system endowed with the same motion of rotation, the points A and B being fixed. Under the influence of the force $T_A - T_B$, the point C will tend to displace itself along AB , and we may assume that this will produce a change in the distribution of the electric charges, or a species of polarisation proportional to the displacement and opposing it. The rotation of the system will create a magnetic field which will likewise be parallel to AB and proportional to $T_A - T_B$. It follows from the above that a corpuscle placed in this field will emit a circular vibration of frequency proportional to $T_A - T_B$ and we shall have—

$$\pm \nu = N(1/n^2 - 1/m^2), \quad \text{or} \quad \pm \nu = N[1/n^2 - 1/(m-\frac{1}{2})^2] \quad (n, m=1, 2, 3, \dots),$$

N being a constant. For $n=2, m=2, 3, 4$ or *vice versa*, we obtain formula (1). To $m=1$ and the other values of n , correspond lines situated outside the known part of the spectrum, but whose existence is rendered probable by

analogy of other spectra. [See Abstracts Nos. 72 and 2596 (1904).] To each of the states of dynamical equilibrium, in number infinite, of this whirling system corresponds a vibration emitted by the corpuscle, and the assemblage of these vibrations reproduces exactly the spectrum of hydrogen. The author also traces the proportionality between $T_A - T_B$ and the magnetic force parallel to H by another method, in which the points A, B, C are replaced by spheres. A. E.

824. *Series in Spectra.* A. W. Conway. (Roy. Dublin Soc., Proc. 11. 15. pp. 181-188, March, 1907.)—In the line spectra of various elements series of lines have been discovered whose frequencies may be connected by formulæ. A typical formula is that of Kayser and Runge, in which the frequency of any line of the series is given by $A + Bn^{-2} + Cn^{-4}$, where n is one of the natural numbers 3, 4, 5, &c., and A, B, and C are constants for the substance in question, e.g., for hydrogen $C = 0$ and $B = -4A$. According to modern ideas the atom is made up of positive and negative electrons in equilibrium, or in steady motion, and the spectrum is formed by the electromagnetic waves due to the motion of these electrons. The electrons may be many or few. In this paper an attempt is made to explain a series spectrum on the supposition that it is due to the motion of one electron. The field of force round a fixed centre is represented by $F(r)$, thus if m is the mass and $-e$ the charge of an electron, its equation of radial motion is given by $m\ddot{r} = -eF(r)$. Further, if a is such that $F(a) = 0$ and r is put equal to $a + x$, we have for small radial oscillations about the sphere of radius a , the equation $m\ddot{x} = -\alpha F'(a)$, so that for stable equilibrium $F'(a)$ must be positive. The frequency is then given by $(1/2\pi)\sqrt{eF'(a)/m}$. Thus, to produce a series of frequencies similar to a spectral series, we must find a function $F(x)$ such that for certain zeros a —

$$F'(a)e/m \propto (A + Bn^{-2} + Cn^{-4} \dots)^2,$$

where $n = 3, 4, 5, \dots$. The forms of the function which satisfy this and the way such fields of force might be conceived as arising are then discussed.

E. H. B.

825. *Emission Spectrum of the Electric Arc in Mercury Vapour.* E. Castelli. (Atti dell' Assoc. Elett. Ital. 10. pp. 85-89, Sept.-Oct., 1906.)—The emission spectrum produced by a "Uviol" lamp contains sixteen lines—two yellow, one green, one blue, three indigo, three violet, and six in the ultra-violet region, the spectrum being identical with that given by a Geissler tube containing mercury, but having in addition lines corresponding to the wavelengths 4115.8, 8942.8, and 8982.7. No absorption spectrum could be obtained using as source of white light an electric arc with Dubosq regulator.

W. H. St.

826. *Influence of Pressure upon the Breadth of Spectrum Lines.* O. Schönrock. (Ann. d. Physik, 22. 2. pp. 209-226, Feb. 5, 1907.)—The author calculates the mean free paths of the gas particles from Michelson's observed half-breadth of certain spectrum lines, and finds that they are much smaller than those calculated from the kinetic theory. This, he shows, may be accounted for by the ionisation of the gas, as the mean free path decreases with increasing ionisation.

E. C. C. B.

827. Purity and Intensity of Monochromatic Light Sources. P. G. Nutting. (Bureau of Standards, Bull. 2, pp. 439-466, Dec., 1906.)—An investigation into the conditions under which a maximum ratio of intensity to purity may be obtained with spectrum lines. The author gives first a definition of the impurity of a light-source in which every component is weighed according to its intensity. If λ_c be the centre of luminosity and E the intensity of a component of wave-length λ then—

$$\lambda_c \equiv \frac{E_1\lambda_1 + E_2\lambda_2 + \dots}{E_1 + E_2 + \dots} = \frac{\int \lambda dE}{\int dE}.$$

The impurity I is defined by (in wave-length units)—

$$I \equiv \frac{E_1(\lambda_1 - \lambda_c)^2 + E_2(\lambda_2 - \lambda_c)^2 + \dots}{E_1 + E_2 + \dots} = \frac{\int (\lambda - \lambda_c)^2 dE}{\int dE}.$$

The author defines the specific impurity I_s by $I_s = I/\lambda_c$. As an example, the specific impurity of the sodium yellow line is 0.00049. The author deals with various spectrum lines, which may be divided into two classes—normal and composite. The normal lines are single and narrow when from a feebly excited source and with increasing intensity broaden continuously with reversal or doubling at some intermediate intensity. Composite lines consist of aggregates of lines more or less fixed in position and relative intensity, and which cannot be resolved by means of a prism or grating. This latter class consists of many types characterised by the form and variability of their components. The author points out that the structure of a composite line should be carefully studied before being used as a monochromatic source. For example the Hg line $\lambda = 4047$ has a specific impurity of 0.000016, or about 2 parts in 100,000, which is prohibitive for the best work. For ultimate standards of length the specific impurity should not exceed 1 in 100,000,000, for interferometry 1 in 10,000,000, and for standards of wave-length 1 in 500,000. The highest obtainable purity is of necessity to be found in normal lines, and indeed those normal lines which have the least minimum width and which increase in width least rapidly with increasing intensity and density of the radiating gas. Details are given of investigations into various lines, and the conclusions arrived at are as follows: The most nearly homogeneous light-sources yet studied are some of the satellites of the composite lines. Three satellites of $\text{Hg}\lambda = 5461$ are homogeneous to well within 1 in 5,000,000, but their employment involves the use of an echelon grating for their segregation. These lines also appear to be free from the Doppler-effect. Second in homogeneity at moderate intensity are the normal arc lines which at atmospheric pressure have a specific impurity of 1 in 500,000, and at low pressures of 1 in 4,000,000. Of third rank are the composite lines produced in vacuum tubes. These have a width (between extreme components) varying from 0.1 to 0.8 tenth-metre or more. The purest, namely, the Zn and Cd lines, have a specific impurity varying from 1 in 1,000,000 to 1 in 60,000. E. C. C. B.

828. Investigation of Five Infra-Red Metallic Spectra. W. J. H. Moir. (Konink. Akad. Wetensch. Amsterdam, Versl. 15, pp. 469-474, Jan. 11, 1907. Proc., 9, pp. 544-548, Feb. 21, 1907.)—The metals investigated were sodium, potassium, rubidium, caesium, and mercury. The present brief account is a preliminary one. In the case of the alkalis the metallic salts were volatilised in the arc in the usual way. The image of the arc is projected by a concave

mirror on the slit of a reflecting spectrometer; the rays are analysed by a rock-salt prism and part of the spectrum so formed falls on a linear thermopile of iron and constantan. The slit and pile are fixed in position, the prism is rotated through small angles. The author has devised a simple method of recording the spectral intensity curve on a photographic plate, in order to avoid the labour of reading the galvanometer and simultaneously noting the position of the prism. Continuous recording is replaced by a series of dots, and the continuous rotation of the spectrometer by an intermittent motion. The position of the prism corresponding to any recorded intensity is found, not by measuring a length, but by counting dots. The zero positions as well as the deflections of the galvanometer are recorded, and hence the radiation-intensities on the spectrogram can be determined even when the surrounding temperature, and therefore the zero, is variable. A spectrum ranging from 0.7 to 6μ was recorded, with 200 displacements of the spectrometer, in two hours. The refractive index for the unknown ray is obtained by a simple calculation, and hence the wave-length is derived. The author tabulates the indices (for rock-salt at 20°C.), wave-lengths, and intensities of 11 or 12 lines for each of the metals Na, K, Rb, and Cs. These lines lie between 0.7μ and 4.0μ . For the investigation of the mercury spectrum a mercury arc-lamp was devised, furnished with a rock-salt window. No measurable emission was found for mercury beyond 1.7μ ; the wave-lengths of five mercury lines between 1.0μ and 1.7μ are tabulated. A. E.

829. *Photography of the Infra-Red Spectrum.* G. Millochau. (Comptes Rendus, 144, pp. 725-727, April 8, 1907.)—In former notes [Abstracts Nos. 1876, 1565 (1906)] the author described experiments in registering the infra-red spectrum by the Waterhouse method, which is based on the inverse action of the infra-red rays, and consists in solarising an ordinary photographic plate and then exposing it to the solar spectrum. It was noted that the action of the infra-red rays was superficial, and that the author was therefore led to use plates tinted with a colouring medium strongly absorbing the actinic rays. Chrysoidine and erythrosine were stated to give good results. The author now mentions that he has since obtained much better results by the use of malachite green. He has prepared plates with it which are ten times as sensitive as ordinary commercial plates to the extreme red and infra-red rays when Waterhouse's method is applied. Very sensitive gelatine-bromide plates (Lumière Σ) are immersed for 10 min. in distilled water with a few drops of acetic acid added, then for the same time in a saturated alcoholic solution of malachite green; they are then rinsed rapidly and dried; all these operations being carried out in the dark. The plates thus prepared are "solarised" for 30 sec. at distance 75 cm. from a 4-c.p. electric lamp, then exposed in the spectrograph. By interposing a violet screen between the plates and the lamp when solarising (3 or 4 min. at 80 cm. from the lamp) they are rendered still more sensitive. Photographs thus obtained of the solar spectrum from 0.750μ to 0.950μ , in which an Ångström unit covered about 0.1 mm. , were exhibited to the Academy, and also photographs of the A band, taken in the third-order grating spectrum, which showed the structure of this band to be similar to that of the B band. The Z line, mentioned in the Note of July 9 [*loc. cit.*] as being a narrow band degraded towards the infra-red, is resolved into lines in the spectrum of the second order. The Mont Blanc spectrograph used in the experiments, which has achromatic objectives of 8 cm. diam. and 80 cm. focus, and a plane grating, is not especially well adapted for such work. Trials with a spectrograph of low dispersion, having a carbon

bisulphide prism, show that the inverse action above described extends from about 16000 down to as far in the infra-red as the optical parts of the instrument allow to pass. The exposure required with this spectrograph is only 30 sec. Wratten panchromatic plates, which are extremely sensitive to red, give the B band with an exposure 5 or 6 times shorter than the author's plates, but require a much longer exposure for the A band, and are insensitive to the infra-red beyond A.

830. *Absorption Spectra of Certain Salts in Aqueous Solution as affected by the Presence of other Salts with large Hydrating Power. Absorption Spectra of Certain Salts in Non-Aqueous Solvents, as affected by addition of Water.* H. C. Jones and H. S. Uhler. (Amer. Chem. Journ., 87, pp. 126-196, Feb., and pp. 207-274, March, 1907.)—A long and interesting investigation into the absorption spectra of CoCl_2 , CuCl_2 , and CuBr_2 in solution, first in water alone and then in the presence of such salts as CaCl_2 and AlCl_3 , and secondly in non-aqueous solvents. The authors conclude that the absorption bands are due to optical resonance, and that the whole of the phenomena connected with these salts are to be explained, by hydration. As the water molecules condense round the absorbing molecule its period of vibration will be interfered with and the absorption band will become narrower, and those solutions in which the hydrates are most complex will have the narrowest absorption bands. Inasmuch as the hydrates have previously been shown to be more complex the more dilute the solution, it would be expected that with these coloured salts the absorption bands would be narrower in dilute solution. This is found to be the case. Similarly, the addition of dehydrating salts broadens the absorption bands. In the second paper the spectra of the salts in solution in methyl and ethyl alcohols and acetone are described. The bands are the widest possible in these solvents, but become progressively narrower on the addition of water. Full plates are given.

831. *Relation between Absorption Spectra and Optical Rotatory Power. Part I. The Effect of Unsaturation and Stereoisomerism.* A. W. Stewart. (Chem. Soc., Journ. 91, pp. 199-209, Feb., 1907.)—Within certain limits a close relation exists between the molecular rotivities of two substances and their absorption spectra. The loss of two hydrogen atoms from a compound (by which a single bond is replaced by a double one) produces an increase in absorptive power as well as a rise in molecular rotivity. The loss of four hydrogen atoms also produces an increased absorption, though it has not such a great effect as the change from the single to the double bond; the same is true for the molecular rotation. In the case of stereoisomeric substances the compound having the greater molecular rotation has also the greater absorption; this rule does not hold in the case of structure isomerides, at least in the unsaturated series. In homologous series the compound having the greatest molecular rotation will have the greatest absorptivity. D. H. J.

832. *Influence of a Strong Magnetic Field on the Spark Spectra of Titanium, Chromium, and Manganese.* J. E. Purvis. (Cambridge Phil. Soc., Proc. 14, pp. 41-84, March 6, 1907.)—A continuation of the author's investigation of the Zeeman-effect [see Abstracts Nos. 1397 (1906) and 53 (1907)]. The strength of the field employed was 89,980 units, and the results are expressed in terms of $\Delta\lambda/\lambda$ for the various lines. It is found that there are several types in the appearances of the resolved lines of the three metals in question;

the components of some are diffuse, but those of others are sharp and well defined. The general rule is, that of the magnetic triplets the middle constituent is at least twice as strong as either of the others, though in certain cases this was not the case. The components of the strongest and most intense lines are not usually most widely separated. Certain simple numerical relations are to be observed between the values of $d\lambda/\lambda^2$ in the case of the components of certain lines; for example, the line $\text{Ti } \lambda = 3262.08$ gives 6 components, and the values of $d\lambda/\lambda^2$ are in the ratio of 1:8:6. Again, several lines can be compared in having identical values of $d\lambda/\lambda^2$.

E. C. C. B.

833. Theory of Phosphorescence and Fluorescence. J. de Kowalski. (*Comptes Rendus*, 144. pp. 266-269, Feb. 4, 1907. *Phil. Mag.* 13, pp. 622-626, May 1907.)—This is an attempt to reduce phosphorescence and fluorescence to a common cause. J. J. Thomson assumes that a grouping of electrons making up an atom produces light at the instant when its internal energy passes beyond a certain critical value, which may be reached either by an elevation of temperature or by the impact of electrons from outside. The author supposes every phosphorescent body to contain two distinct systems of electron groupings, which he calls electro-nogens and luminophores respectively. The former expel electrons under the influence of light and other agencies, while the latter possess an internal energy closely approaching the critical energy. In fluorescent bodies the luminophores only shine out while the electrons from the electro-nogens are traversing them. Phosphorescent bodies, on the other hand, have the property of gradually radiating out sufficient energy to reduce the energy of the luminophores below the critical value. In solid solutions the active metal represents the luminophore, and the sulphide a substance capable of freely emitting electrons. The same substance may contain several distinct luminophores, each of which gives rise to a distinct spectrum.

E. E. F.

834. Phosphorescence of Uranium Salts in Liquid Air. H. Becquerel. (*Comptes Rendus*, 144. pp. 459-462, March 4, and pp. 671-678, March 25, 1907.)—These papers give elaborate tables showing the wave-lengths of the observed lines of the spectra at ordinary temperatures and in liquid air of nitrate of uranium, double sulphate of uranium and potassium, double chloride of uranium and potassium, a ruby, Iceland spar and various platinum-cyanides. The identity of the modifications presented by each band of the spectrum of a given salt is held by the author to furnish a new proof of the unity of origin of all the bands of uranium compounds, whether in the emission spectrum by phosphorescence or in the absorption spectrum. [See also Abstract No. 625 (1907).]

E. H. B.

835. Secondary Röntgen Radiation. J. J. Thomson. (*Cambridge Phil. Soc., Proc.* 14. pp. 109-114, March 6, 1907.)—McClelland has shown that there is a close connection between the secondary ionisation given out by a substance exposed to the β - and γ -rays from radium, and the atomic weight of the body. The experiments described in this paper show that a very intimate relation exists between the secondary Röntgen radiation and the atomic weight of substances, and that this relation varies with the hardness of the primary rays. The curves showing the relation between the secondary radiation and atomic weight indicate that in every case observed, except that

of nickel, an increase of atomic weight is accompanied by an increase in the stream of radiant energy. From the curves it would be concluded that the atomic weight of nickel is greater than that of cobalt. [See also Abstracts Nos. 580 (1906) and 648 (1907).] J. J. S.

836. Atomic Weight of Nickel. F. E. Hackett. (Nature, 75, p. 585, April 4, 1907.)—Barkla has given reasons, based on experiments with secondary Röntgen radiation, for assigning to nickel an atomic weight of 61.3 instead of the usually accepted value of 58.7 [see Abstract No. 648 (1907)]. McClelland showed [Abstract No. 1897 (1905)] that the intensity of secondary β -radiation from different elements for the same exciting primary β -rays depended on the atomic weight, and that a small difference in atomic weight could be detected in this way. The author of the present paper has repeated the observations of McClelland, using a very sensitive apparatus. Cobalt and nickel gave practically the same secondary radiation; if there is any difference, that given by cobalt is slightly the greater. The values found for these elements, compared with those obtained for copper and iron, correspond with their relative positions in the table of atomic weights. These results obtained with secondary β -radiation do not, therefore, point to the conclusion suggested by Barkla, and are in good agreement with the chemical determination of the atomic weight of nickel. A. W.

837. Radio-activity of Radium. Kelvin. (Phil. Mag. 18, pp. 818-816, March, 1907.)—A plan of the atom proposed by the author to account for radio-activity has been previously given [Abstract No. 247 (1906)]. For the electron there is one position of stable equilibrium near the boundary of the atom, with very small potential energy; and another position of stable equilibrium at the centre, with very great potential energy. If the electron is in the first position the atom is said to be unloaded, in the second position loaded. Suppose now a crystal of a radium salt with every radium atom in it unloaded. Loading sets in, until in a few months, perhaps, a permanent average of loadings and unloadings will be reached. The energy of loading is taken from the energy of thermometric heat in the crystal, and thus a cooling is experienced. In the unloading electrons will be projected out of the atom with enormous velocities; this is called a discharge. If the discharge sends the electron into the crystal, the recoil will project the unloaded atom outwards, but with comparatively small velocity and energy. Hence according to this view the heating effect of radium is produced chiefly by the β -rays. The process can go on for ever without any large store of potential energy in the loaded atom. The author supposes that the necessary energy is obtained by heat conduction or radiation from the material external to the atom. R. S. W.

838. Radio-active Matter in the Earth and the Atmosphere. G. A. Blanc. (Phil. Mag. 18, pp. 378-381, March, 1907.)—As the paper is apparently a preliminary communication, the chief result alone is given here. This is that the excited activity obtained by exposing a negatively charged wire to the open air consists in the main of the transformation products of radio-thorium, provided the exposure is a long one. R. S. W.

839. Ionisation of Various Gases by α -Particles. W. H. Bragg. (Phil. Mag. 18, pp. 388-387, March, 1907. Paper read before the Physical Soc.,

Feb. 22, 1907; in part before the Roy. Soc. of S. Australia.)—The hypothesis is advanced that δi , the ionisation produced in consequence of the expenditure of a small quantity of energy δe by the α -particle, is related to the latter quantity by the equation $\delta i = k(v)\delta e$, where $f(v)$ is a function of the velocity only and k a constant for each gas. This constant is called the specific ionisation of the gas for α -radiation, air being taken as the standard. If a homogeneous source of α -rays is used and the ionisation curve is plotted, as in the author's method of finding the range of the α -particles, the area enclosed by this curve and the axes can be taken to represent the total ionisation produced by the α -rays. The ratio of the areas thus obtained with different gases gives the constant k above if air is the standard. The author shows that it is advantageous and allowable to represent these areas by the product RI of the range and ionisation corresponding to a typical point on the curve. Tables giving k for a large number of gases and vapours are included; it is seen that it varies from gas to gas. From the experiments of Rutherford and the author it appears that the energy spent and the ionisation produced are not directly connected, for the former is related to the atomic weight by a simple law and the latter is not. It is therefore supposed that the α -particle produces a primary effect A, which may or may not be ionisation, and this in turn a secondary effect B which is ionisation. It is shown that $f(v) = 1/v$, or that the ionisation produced at different points of the path in any gas is proportional to the time spent by the α -particle in crossing the atom. If s is the stopping power, the quantity ks represents the specific ionisation of the molecule, and this is found to be closely related to the molecular volume, molecular refraction, &c. Tables showing this are given. A description, with plate, of the apparatus used in finding the ionisation curves is given. R. S. W.

840. *Influence of Velocity on Stopping Power for α -Particles.* W. H. Bragg. (Phil. Mag. 13, pp. 507–516, April, 1907. Paper read before the Australasian Assoc. for Advancement of Science, Jan. 9, 1907.)—Some years since the author and Kleeman found that the slower α -particles were slightly less affected than the swifter ones by the interposition of metal sheets [Abstract No. 2061 (1905)]. Kučera and Mašek have now suggested that the stopping power is proportional to the velocity of the particle [Abstract No. 1870 (1906)]. From the experiments described in this paper the author concludes that while, in some cases, the stopping power is affected by the velocity, this influence is much less than Kučera's statement would lead us to believe. The stopping power of aluminium is apparently unaffected by its distance from the radium, and is therefore independent of the velocity of the α -particles. On the other hand, the stopping power of gold increases with the velocity of the particles. The effect is, however, very small; it seems also to be greater the larger the atomic weight of the metal. It is clear, therefore, that the proportionality between the stopping power and the square root of the atomic weight is not exact, except possibly at some particular speed. The general truth of the law is not, however, affected. R. S. W.

841. *Absorption of β -Rays.* J. A. McClelland and F. E. Hackett. (Roy. Dublin Soc., Trans. 9. 4, pp. 37–50, March 22, 1907.)—The intensity of the secondary radiation has previously been found to depend markedly on the atomic weight of the substance acted on by primary β -rays from radium [Abstract No. 897 (1906)]. This suggests that the coefficient of absorption

might also show this dependence. It is shown by a theoretical investigation that the coefficient of absorption, as usually measured, depends on the quantity of secondary radiation emitted by successive layers of the absorbing substance. If μ is the true coefficient, i.e., what the coefficient would be if there were no secondary effects, κ the ratio of the secondary energy emitted by a thin layer to the incident energy absorbed by it, it is shown that the coefficient of absorption of the total radiation, partly primary and partly secondary, is $\mu \sqrt{1 - \kappa}$. It is further shown that this differs from λ , defined by the equation $I = I_0 e^{-\lambda x}$, in all cases except when κ is great. The experiments give $\mu \sqrt{1 - \kappa}$, of which κ has been found in the previous paper. Two methods are used: one in which the radiation is measured after passing through a thick plate of the substance, the other depending on measurements of the secondary radiation from the first face of the absorbing material for a small thickness and for a thickness large enough to absorb all the rays. μd , where d is the density, is found to increase with the atomic weight. Further, the elements fall into divisions with respect to this ratio, the divisions being the same as the chemical periods.

R. S. W.

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842. *Improvements in Spectrophotometers.* F. Twyman. (Phil. Mag. 13. pp. 481-488, April, 1907. Paper read before the Physical Soc., Jan. 25, 1907.)—A spectrophotometer of the Hüfner type which by an addition is converted into a polarimeter, by means of which optical rotations can be measured for light of any wave-length in the visible spectrum. The mode of correction of a serious error to which polarisation spectrophotometers are liable is dealt with. L. H. W.
843. *New High-speed Photographic Shutter.* (Scientific American, 96. p. 274, March 30, 1907.)—Description of a mechanism invented by G. Dietz, in which four blades are made use of, permitting a uniform illumination of the plate and securing definition without distortion. The lens is opened from the centre in an increasing star, and closes again from a different point of the lens-aperture's periphery. This is a between-lens shutter; it is driven by an adjustable spring, and appears to be free from the objections raised against the focal-plane shutter when used at high speeds. The shutter can be applied to any camera for any class of work. G. E. A.
844. *Anomalous Dispersion of Magnetic Rotation.* F. Drepper. (Phys. Zeitschr. 8. pp. 86-87, Feb. 1, 1907.)—A preliminary paper on the same work as that of Ellas [see Abstract No. 51 (1907)]. Schmauss's method is used and dispersion curves are given for fuchsin and eosin. G. E. A.
845. *Magneto-optics of Crystals.* J. Becquerel. (Comptes Rendus, 144. pp. 682-685, March 25, 1907.)—Deals both theoretically and experimentally with this subject, treating the magnetic rotation of the plane of polarisation in the neighbourhood of absorption bands and the magnetic rotatory power of crystals at the temperature of liquid air. The results of the experiments on *xenotime* and *tysonite* furnish an important confirmation of the theoretical conclusions. [See also Abstracts Nos. 286 and 625 (1907).] E. H. B.
846. *The Laws of Radiation.* O. Lummer. (Elect. Rev., N.Y. 50. pp. 530-531; Discussion, pp. 531-532, March 30, 1907. Paper read before the Illuminating Engin. Soc., New York.)

847. Incandescent Mantles. Foix. (Comptes Rendus, 144, pp. 685-687, March 25, 1907.)—A theoretical examination of the respective parts played by thoria and ceria, the optical efficiency being traced to the latter, whose fragility, however, necessitates the former. E. H. B.

848. Fluted Spectra and Supplementary Flutings from Parallel Gratings. G. Meslin. (Comptes Rendus, 144, pp. 321-324, Feb. 11, and pp. 689-692, March 25, 1907.)—A mathematical discussion of the production of flutings which appear in the spectra when light from a narrow slit falls upon parallel gratings under the conditions for the pure spectrum. E. H. B.

849. Structure of very narrow Spectrum Lines. O. v. Baeyer. (Deutsch. Phys. Gesell., Verh. 9. 4, pp. 84-90, Feb. 28, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—A repetition of previous measurements with the interference-point apparatus but with greater resolving power. The mercury spectrum especially was examined and one line of bismuth; certain small differences from the previous paper [Abstract No. 1395 (1906)] are recorded. E. C. C. B.

850. Distribution of Light in Dispersion Bands. W. H. Julius. (Astrophys. Journ. 25, pp. 95-115, March, 1907. Paper communicated in part to the Roy. Acad. of Sciences of Amsterdam.) [See Abstract No. 238 (1907).]

851. Temperature Emission of Iodine Vapour. M. Reinganum. (Phys. Zeitschr. 8, pp. 182-183, March 15, 1907.)—A criticism of Fredenhagen's paper [Abstract No. 639, 1907]. The conclusion of the latter that at constant temperature iodine vapour gives a continuous spectrum is not accepted. G. E. A.

852. Wave-lengths of Röntgen Rays. J. D. van der Waals, Jr. (Ann. d. Physik, 22. 3, pp. 603-605, March 5, 1907.)—A discussion of the various determinations or estimates hitherto made of the wave-lengths of Röntgen rays in which a doubt is cast upon the value found by W. Wien, 2.3×10^{-10} cm., in view of that due to Haga and Wind's refraction experiment, from which Sommerfeld derived a mean value of 1.3×10^{-8} cm. [See also Abstracts Nos. 1400 (1905), 348 and 2033 (1906).] E. H. B.

853. Radio-active Matter. E. Weiss. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a, pp. 1285-1320, Oct., 1906. From the II. phys. Inst. d. k.k. Univ., Wien.)—Gives a description of experiments on the deposition of radio-active material from the atmosphere. Elster and Geitel's and Gerdien's methods are criticised. The chief interest of the paper is in the numerous tables of results, for which the original should be referred to. A. W.

854. Radio-activity of the Chemical Elements. C. W. Raffety. (Nature, 74, p. 444, Aug. 30, 1906.)—A suggestion that the emission from the radio-active elements of corpuscles with velocities below the critical velocity necessary for the ionisation of gases may be a general property of the chemical elements. Very feeble γ -radiation may be set up in some cases, and certain mysterious instances of the fogging of photographic plates may be due to the occurrence of such radiation caused by the impact of slow-moving corpuscles. J. J. S.

855. Radio-activity of Rain. G. Costanzo and C. Negro. (Phys. Zeitschr. 7, pp. 921-924, Dec. 15, 1906. From the Italian.)—Further experiments carried out in the period March-May, 1906, have resulted in the same conclusions being arrived at for rain as previously for snow [see Abstract No. 1390 (1906)]. In addition, it is found that in the case of thunderstorm precipitations, and especially if accompanied by hail, the radio-activity is notably stronger. L. H. W.

HEAT.

856. *Volume-changes of Cast Iron.* A. Messerschmitt. (Zeitschr. f. Werkzeugmaschinen, pp. 135-137, Jan. 5, 1907. Stahl u. Eisen, 27. p. 463, March 27, 1907.)—One half-hour after pouring a bar 65×65 mm. $\times$ 1 m. long had expanded 2.8 mm.; its length 1 hour after pouring was that of the mould. It then continued to contract until, 10 hours afterwards, it was 10 mm. shorter than the mould. F. R.

857. *Influence of Surrounding Temperature on Glow-lamp.* F. Laporte and R. Jouaust. (Comptes Rendus, 144. pp. 688-689, March 25, 1907.)—An electric incandescent lamp was tested as to c.p. and current with the temperature of the enclosure at 15° and when raised to 115° , also during warming and cooling. The c.p. scarcely varied, the difference of the extreme measures being only 1/100. The current varied by only about 1/2000. According to the theory of Stefan the radiation is proportional to $(T^4 - T_0^4)$, and according to Guillaume, based on the work of Lummer and Kurlbaum, the brightness of the "black body" is proportional to $T^3(T - 650)^\circ$, whence the present author finds that the temperature would only increase by 0.5° C. over the value of T assumed for incandescence (viz., 1,800) consequent upon a rise of temperature of 100° in the enclosure. E. H. B.

858. *Distribution of Velocities.* O. Postma. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 498-506, Jan. 11, 1907. Proc., 9. pp. 492-501, Jan. 24, 1907.)—In a former paper [see Abstract No. 738 (1906)] objection was taken to Boltzmann's and Jeans' proofs that Maxwell's law represents the most probable state of a gas, an *a priori* assumption being made as to the probability of the velocity-point of an arbitrary molecule falling into an arbitrary space-element. The law is, however, deducible by their analysis without this assumption if applied to Gibbs' microcanonical ensembles; but the existence of such ensembles is now assumed. Criticism of Boltzmann's deduction of the H-theorem is also made, and it is shown that a special definition has to be given of collisions that are of opposite kind. R. E. B.

REFERENCES.

859. *Planck's Theory of Radiation.* A. Einstein. (Ann. d. Physik, 22. 4. p. 800, April 4, 1907.)—Correction is here made of two statements in a former paper [Abstract No. 439 (1907)]. R. E. B.

860. *Boltzmann's Theory of Collisions of the Most General Kind.* K. v. Wesendonk. (Phys. Zeitschr. 8. pp. 179-182, March 15, 1907.)—Boltzmann's reasoning is examined in detail so as to bring out clearly the assumptions that are made at different points. R. E. B.

861. *Formulation of the First Law of Thermodynamics for Gases.* F. W. Adler. (Ann. d. Physik, 22. 4. pp. 782-790, April 4, 1907.)—The author thinks that, as for a perfect gas the intrinsic energy depends on temperature only, it is incorrect to employ the notation $\partial U/\partial T$ or to denote by C_v the factor of dT in the expression for dQ , and he wishes to employ a specific heat at constant internal pressure. [But he seems to be quite unaware that the expression for dQ implies a continuous equilibrium-process, and that it is not applicable in the case of a change of volume without performance of external work.] R. E. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

862. *Electron Theory.* E. Lecher. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1827-1884, Oct., 1906. From the phys. Inst. der k.k. deutsch. Univ., Prag.)—Formulates the fundamental phenomena of electromagnetic induction and of electrodynamical force from the point of view of the electron theory, using the modern view, due to Lorentz, of a single species of electrons, possessing a negative charge. Let their number be N per c.cm. and their charge e electrostatic units. Let u be the speed of a particular electron flying free in a conductor. If the components of the velocity in rectangular co-ordinates are u_x, u_y, u_z , we must have $\Sigma u_x = \Sigma u_y = \Sigma u_z = 0$, since otherwise there would be a permanent current in one of these directions. Now let a c.cm. of the conductor be exposed to a magnetic field in the direction z . Then, while the component u_x remains unaltered, the force on an electron flying with velocity u_x is $k_y = +eHu_x$ in the y -direction. The total force on all the components is $K_y = eH\Sigma u_x$, which is zero. Similarly $K_x = 0$; in other words, there is no resultant action on the metal due to the magnetic deflection of its free electrons. This holds good so long as the metal is not moved or traversed by an electric current. But now let the metal be displaced in the direction $-x$ with a speed v . This alters the relative velocity of the electrons and the magnetic field. This alteration can only apply to the x -components. The relative velocity now becomes $u_x - v$, and the total force—

$$K_y = eH(\Sigma u_x - \Sigma v) = -NeHv$$

per c.cm. If ϕ is the p.d. and η the length in the y -direction, we have $\phi = +\eta Hv$. The positive sign is adopted because, although the electrons are urged downwards, the conventional "current" will tend to flow upwards. The equation holds good for both the electrostatic and electrodynamic systems of units. A precisely equal and opposite force acts upon the positive metallic atoms. But as they are practically stationary, they do not contribute to the current. When the metal does not move, but is traversed by a current, there is again a differential velocity with respect to the magnetic field, but the magnetic field now acts upon the electrons only, since the positive atoms do not move with respect to it. The result is a force proportional to the field, the current, and the length of the conductor, which acts upon the body of the conductor itself. E. E. F.

863. *General Theorems in Electrotechnics.* M. Latour. (Écl. Électr. 51. pp. 5-12, April 6, 1907.)—There are certain impossible operations in electrotechnics which are continually being brought forward by inventors. One of these is to obtain a self-exciting system of alternating currents without the help of condensers or commutators. It is impossible to adjust the resistances and inductances of a set of circuits so that when an alternating p.d. is applied at any two points the resulting current will be in advance in phase of the applied p.d. The author gives a perfectly general proof of this theorem by

means of simple theorems in determinants. His theorem may be stated in the following form: If an alternating e.m.f. be made to act on a complex system of fixed circuits having negligible capacity; then the resulting current is the same as if the e.m.f. acted directly on an inductive coil of a certain resistance and inductance. If $L_{11}, L_{12}, \dots, L_{21}, L_{22}, \dots$ be the inductance coefficients of a group of p circuits, it is also proved that the determinant—

$$\begin{vmatrix} L_{11} & L_{12} & \dots & L_{1p} \\ L_{21} & L_{22} & \dots & L_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ L_{p1} & L_{p2} & \dots & L_{pp} \end{vmatrix}$$

is always greater than zero. Finally, the author considers the case when there are p e.m.f.'s applied to the system, and proves that in this case also the magnetising power is always positive. A. R.

884. *Electrification produced by Heating Salts.* J. J. Thomson. (Cambridge Phil. Soc., Proc. 14. pp. 105–108, March 6, 1907.)—Beattie found that when sodium chloride mixed with iodine is sprinkled on a metal plate, large quantities of positive electricity and some negative electricity are given off when the plate is heated to a temperature somewhat over 300°C . Wehnelt has shown that when an oxide of calcium or barium is heated large quantities of negative electricity are given off. The experiments described in this paper were made to find whether there is any relation between the sign and amount of the electricity given off, when the salt is heated, and the chemical nature of the salt. The salt tested was placed upon a thin sheet of mica wrapped round a porcelain tube, which was heated by passing an electric current through a badly conducting powder packed inside. The electrification given off by the salt was tested by means of a saddle-shaped conductor suspended over the salt, carried by an insulated rod joined to an electroscope, whose rate of leak was determined in each case. The phosphates of eight metals were examined, and were found to give off positive electricity when heated, the greatest quantity being liberated by the heating of aluminium phosphate. There is no visible chemical decomposition. The amount of electricity given off by the phosphates is of quite a different order from that given off by clean metal at the same temperature. Nitrates on heating soon become converted into oxides, but at first they give off positive electricity. Chlorides give a small excess of positive, while the oxides (especially those of Ca and Ba) give out an excess of negative electricity on heating. The sign of the electrification remaining on the salt itself (opposite to that given off) is the same as that produced on the salt by friction. This was tested by rubbing the salt in a mortar and then pouring it into an insulated cylinder connected to an electroscope. The process of electrification seems to be the same in the two cases. The salts appear to be covered by a double layer of electrification, in the case of the phosphates the positive layer being outside. In all cases of electrification by friction the effects may be due to the removal of one or both of the outer coatings of the double layers on the rubbed surfaces. J. J. S.

885. *Electric Discharges and Rain.* C. Negro. (Elettricità, Milan, 27. pp. 128–129, March 1, 1907.)—Traces a connection between lightning and the sudden increase of rain frequently observed after a flash. This may be due either to ionisation and the formation of condensation nuclei, or, more

probably, to opposite motions of oppositely charged droplets due to the electric disturbance of the charge, and their merging into larger drops in consequence of collision. The increase of precipitation becomes noticeable as a rule within a minute after the thunderclap. Hail also shows a noticeable increase after a lightning discharge. E. E. P.

888. *Measurements of Electric Potential during the Total Solar Eclipse, Aug. 30, 1905, at Tripoli.* E. Oddone. (Terrestrial Magnetism, 11, pp. 167-180, Dec., 1906.)—The author took charge of the electric observations in the expedition of the Carnegie Institution. Two collectors operated by water were used, one communicating with a direct-reading Exner electrometer, the other with two registering and independent electrometers of the Mascart type. The water-droppers were placed at levels differing by 6 m. The discussion is confined to day observations, as the bedewing of the insulators at night interfered with nocturnal registration. For the days before and after the eclipse the mean electric potential had its minimum value, 8 volts, at 5h. 30m. a.m. From 7 o'clock it increased rapidly, attaining a maximum of 205 volts at 10h. a.m. It then fell to a second minimum of 90 volts at 1h. 30m. There was a second maximum of 190 volts at 5h. p.m., after which the fall was rapid. Hot land winds blew in the morning, and sea breezes after 10h. a.m. On the day of the eclipse the desert wind (ghebbi) rose suddenly, and blew all day, clouds of dust passing from time to time across the clear sky. These new meteorological conditions disturbed the measures. On the day of the eclipse the energy and potential were rising from noon onwards, whilst normally the minimum lasted till 1.30 p.m. First contact occurred at 1.30—mid-European time. Four min. after first contact the potential and energy interrupted their rapid ascent, and suddenly began to descend. The course in the afternoon hours was almost the opposite of the normal. At 2h. 38m. shortly before totality (2h. 50m.) a sudden maximum of potential appeared, followed by a sudden fall. (The majority of previous observers have noted that totality is comprised between a maximum and minimum of potential.) Another maximum, less pronounced, took place towards 3h. 40m. p.m. Fourth contact was at 4h. 2m. After 5h. 30m. p.m. the potential showed a tendency to rise again, but there was no symmetry about the hour of totality. Five previous observers (at four eclipses) have recorded a descent of potential after first contact, and the present results lend support to the hypothesis that the passage through the air of the eclipse shadow cone has an influence on the atmospheric electricity. The energy curve shows great similarity to the potential curve, the only discrepancy being possibly due to incomplete insulation. The author concludes with a review of the observations made elsewhere, and finds that evidences of a course common to all the stations seem to exist, though masked in some cases by local variations. The extreme range of variation recorded varied greatly at different stations; thus the differences found at Tortosa, Stax, and Monte Rosa were 20, 100, and 1,000 volts respectively. The author, however, considers that the variations really due to the eclipse did not exceed 40 volts, and that the extremes cited above were certainly not caused by the eclipse. With regard to the question as to why the potential curve did not coincide with the illumination curve, and showed different maxima and minima at different stations, the author throws out a suggestion depending on the observation that the radiant power per unit of apparent solar surface diminishes from the centre towards the limb. A. E.

DISCHARGE AND OSCILLATIONS.

867. Ionisation by Spraying. A. S. Eve. (*Nature*, 75. p. 588, April 4, 1907.)—A strong current of air, filtered through cotton-wool, is passed through a sprayer into a chamber containing an insulated electrode connected with an electroscope. No additional leak is noticed if air alone is used, but an increased leak is found when liquids are so sprayed. This leak persists in some cases for 10–15 min. after spraying has ceased, showing the presence of very slowly moving ions. In most, but not all cases, the positive and negative ions are generated in nearly equal quantities. Small quantities of pure substances can be examined by this method. R. S. W.

868. Measurement of Ionic Velocities in Small Volumes of Gas. J. Franck and R. Pohl. (*Deutsch. Phys. Gesell., Verh.* 9. 4. pp. 69–75, Feb. 28, 1907. *Phys. Inst. d. Univ., Berlin*, Feb., 1907.)—Rutherford's alternating e.m.f. method is modified so as to be applicable to ions of either sign, and only a small quantity of gas is required. Below a metal plate F is a gauze D; these are connected to different points of a resistance through which a current is passing, and so are maintained at a constant p.d. Below D is another plate K; this is connected to one pole, F and D to the other pole of a high-tension transformer. A radiotellurium plate is placed between F and D, and the ions it produces, on account of the p.d. between the plates, are driven through the gauze, and so are found in the alternating field produced between D and K. If the voltage between F, D is properly adjusted, these ions will at first be close to D between D and K, and thus Rutherford's method may be applied just as if they were produced in the first instance at the surface of D. By adjusting the sign of the voltage between F and the gauze, ions of either kind may be used. The method is to be applied to helium. R. S. W.

869. Anode Rays. E. Gehrcke and O. Reichenheim. (*Deutsch. Phys. Gesell., Verh.* 9. 4. pp. 76–88, Feb. 28, 1907. Communication from the *Physikal.-Techn. Reichsanstalt.*)—A continuation of the subject dealt with in Abstract No. 96 (1907). Anode rays can now be obtained without heating the anode, by using very low pressures. They cause the glass to fluoresce green; if they fall on a salt the lines of the metal are given. Their path is apparently independent of the position of the cathode, and they carry with them the salt of which the anode is formed. They appear to possess most of the properties of canal rays. R. S. W.

870. The Magnetite Arc. W. G. Cady. (*Electrician*, 58. p. 816, March 8, 1907.)—Steinmetz [see Abstract No. 85b (1907)] states that the p.d. in the magnetite arc at 1 amp. is higher than the computed value by an amount depending on the length of the arc, and varying from 7 to 15 volts. This is due to the discontinuity which occurs in passing from the hissing to the quiet state. The author has discovered the existence of a well-defined hissing-point for the iron arc [see Abstract No. 2066 (1906)]. The "iron" arc in air really takes place between globules of magnetic oxide of iron. The change from the hissing to the quiet stage usually occurs when the value of the current lies between 1 and 2 amps. The smaller the radius of curvature of the positive globule, the smaller the value of the critical current. At the hissing-point the p.d. abruptly rises 10 to 15 volts, while the current decreases

by a small fraction of an amp. The positive electrode is the seat of the effect. Experiments were made with an arc between a magnetite rod and a block of copper. When the magnetite was the anode the hissing-point was found just as with the iron arc. When it was negative, no discontinuity in voltage and current could be detected so long as the copper was clean. When, however, a trace of iron has become deposited on the copper, the hissing-point showed itself, and was clearly marked on the curve giving the statical characteristic. A quiet state also exists for the copper arc, but it does not begin until the current has been decreased to about 0.5 amp. A. R.

871. *High-pressure Sparking Distances.* L. Cassuto and A. Occhialini. (Accad. Lincei, Atti, 15. pp. 715-721, Dec. 2, 1906. *Elettrocista*, Rome, 6. pp. 88-89, Feb. 1, 1907.)—Experiments were undertaken with a view to testing Paschen's law, according to which the spark potential varies directly as the width of the spark-gap and as the density of the gas. The greatest gaseous pressure used was 102 atmos., and up to that pressure Paschen's law is fulfilled to within 10 per cent., that being the range of experimental error. The sparking distance was varied between 6.8 mm. and 0.1 mm. E. E. F.

872. *Discharge of a Condenser through a Solenoid.* F. Piola. (Accad. Lincei, Atti, 16. pp. 122-130, Jan. 20, 1907.)—The author examines the distribution of the magnetic field and the flux of induction in a bundle of conducting wires forming the core of a solenoid traversed by a sinusoidal current or the discharge of a condenser. He shows that the period of the discharge is proportional to $\sqrt{\mu\delta}$, where μ is the permeability and δ the specific resistance of the material of the core. Thus the period is reduced from unity to 0.0542 by substituting a copper core for an iron core. [See also Abstract No. 699 (1907).] E. E. F.

873. *Function and Nature of the Initial Discharge in the Electric Spark.* G. A. Hemsalech. (Comptes Rendus, 144. pp. 692-694, March 25, 1907.)—The author has previously drawn attention to the change in the nature of the initial discharge with or without extra self-inductance in circuit, as manifested by the spectra obtained [Abstract No. 1089 (1902)]. The discharge without additional inductance is less suitable for the production of oscillations, the damping being so considerable that not more than about ten are obtainable per discharge, owing to the fact that a large proportion of the condenser energy is required to cause the initial discharge to pass. The interval between the initial discharge and the first oscillation has been shown by Tissot to be always greater than that between the oscillations themselves [Abstract No. 491 (1902)]. On increasing the additional inductance up to a certain value, the character of the initial discharge alters, becoming much feebler and requiring less energy to produce it, and hence almost all the condenser energy is available for the production of oscillations; the damping is also very much smaller, 30 or 40 oscillations per discharge being obtainable. The interval between the initial discharge and the first oscillation is in this case very much smaller ($< 10^{-4}$ sec.) than that between consecutive oscillations, and this interval as well as the appearance of the initial discharge, remain constant with further increase of the inductance. The critical value of the self-inductance is found experimentally to be about 0.001 henry, and appears to be independent of the capacity and of the spark-length (between 1 and 8 mm.). The author calls the two forms of discharge to which the self-

inductance gives rise, the capacity spark and the self-inductance spark; in the first case the initial discharge is the first discharge of the condenser, whilst in the second case the initial discharge is only the discharge of the electrodes, and serves solely to make a path for the oscillatory discharge of the condenser. L. H. W.

874. *Theory of Marconi's Directive Aerial in Wireless Telegraphy.* K. Uller. (Phys. Zeitschr. 8. pp. 198-195, April 1, 1907. Phys. Inst. d. Univ., Giessen, March 4, 1907. Ecl. Électr. 51. pp. 178-174, May 4, 1907.)—The author disagrees with Fleming's statement that experimental results have so far confirmed the theory of the bent aerial [Abstract No. 2072 (1906)]. Marconi's and Fleming's experimental results may be accepted as correct. It is shown that if the earth's surface acted like a metallic mirror, as assumed by Fleming in his theory, the result would be a maximum radiation in the direction of the concave side of the radiator which is opposite to that found by experiment. That Fleming has obtained the reverse result, theoretically, is due to an ambiguity in his formula whereby no distinction is made between the motion of the radiator and the motion of a point in the field. His formula would be correct if instead of $\cos \theta$ were written $-\cos \theta$; but this, of course, would upset the agreement between theory and experimental results. The ground therefore does not, even approximately, behave as a metallic mirror, and the explanation of the greater radiation from the convex side must be looked for in absorption of the lines of force on the concave side on account of their greater density, and of their direction, which is more nearly parallel to the ground. J. E.-M.

875. *Syntony Realised by Employment of Bolometric Detectors.* C. Tissot. (Journ. de Physique, 6. pp. 279-284, April, 1907. Paper read before the Soc. franç. de Physique, Feb. 1, 1907.)—The author refers to Poulsen's "continuous" oscillations and then points out that there are other ways of realising good syntonic working, which do not involve the continuous expenditure of such a considerable amount of energy as is required by the arc method. The way the author considers more fully is the employment of a detector, such as the bolometer, which will give an indication proportional to the total amount of energy received. By increasing the number of wave-trains per sec. the amount of energy received is augmented, but this increase is unnoticed by the coherer or the magnetic detector [Marconi's (?)]. The bolometer is not such a sensitive detector, but in this case the increase in the number of wave-trains means an increase in the deflections obtained. The author has tried the Wehnelt break for obtaining greater group frequencies, but the energy available is limited. Better results were obtained with a singing arc, the oscillations from which (8,500 per sec.) were used to supply a Tesla transformer. With this arrangement good signals were obtained at 40 km. with sparks 0.5 to 0.6 cm. in length. An alternator of, say, 500 periods (1,000 trains) per sec. would be much simpler still. It is considered that it is better to put up with the slightly less sharp tuning with slightly damped oscillations than to employ "undamped" oscillations and thus increase the number of wave-trains to an excessive degree, which may involve the expenditure of many thousand times the energy. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

876. *The Weinstein and Stefan Formula for the Mutual Inductance of Coaxial Coils.* E. B. Rosa. (Bureau of Standards, Bull. 2. pp. 881-857

Dec., 1906.)—The formulæ of Rowland, Rayleigh, and Lyle for the mutual inductance of two coaxial coils of rectangular cross-section take second differentials only into account. The formulæ of Weinstein and Stefan, however, take into account differential coefficients higher than the second. Weinstein deduces his formula by starting with Maxwell's expression in elliptic integrals for the mutual inductance of two coaxial circles, differentiating it and carrying the operation to the fourth order of differentials. Stefan, on the other hand, takes Maxwell's expression in a converging series for the mutual inductance of two coaxial circles and differentiates it to terms of the sixth order. The author, by testing the two formulæ, found that they did not agree. He therefore recalculates the formulæ on the lines laid down by the authors, and finds an error in Stefan's formula and a small error in Weinstein's. Making the requisite corrections he finds a satisfactory numerical agreement. Practically all the mathematical working is given, and it can be readily followed. Several numerical examples are worked out. A. R.

877. *The Mutual Inductance of Coaxial Coils.* E. B. Rosa and L. Cohen. (Bureau of Standards, Bull. 2. pp. 359-414, Dec., 1906.)—A very thorough examination is made of the various formulæ which have been proposed from time to time for calculating the mutual inductance of two circular coils of rectangular section. Numerous numerical calculations are made by the various formulæ. It is pointed out which are the most accurate and where some of them fail. New formulæ are deduced which are more convenient in special cases. Curves are drawn showing the relative accuracy of various formulæ for particular coils at varying distances. Weinstein's, Nagaoka's (using Jacobi's q -series) and Coffin's formulæ for circles are also given and numerical examples worked out. Rowland's and Lyle's formulæ agree almost exactly, both being based on the same assumption. They are very accurate when the coils are not near one another. The maximum inaccuracy in the value of the mutual inductance when calculated by the Rosa and the Rosa-Weinstein formulæ is less than 1 in 100,000. The authors conclude that there is no difficulty in calculating the mutual inductance of a pair of coils of equal radii with a maximum inaccuracy of less than 1 in 50,000. The mean radius of the coils can be accurately determined by Bosscha's, Rayleigh's, or Lyle's method with reference to a standard which is capable of being very accurately measured.

A. R.

878. *Measurement of Self-induction.* A. Zeleny. (Phys. Rev. 24. pp. 257-268, March, 1907.)—The Maxwell-Rayleigh method for the measurement of self-induction is theoretically more free from doubtful corrections than any other known method. It has, however, been discarded on account of an experimental difficulty. The unmodified method necessitates, in addition to balancing the bridge and a ballistic galvanometer throw, a measurement of the deflection of the galvanometer produced by the continuous current when one arm of the bridge has been overbalanced by a very small and known amount. After the introduction of this small resistance the resistance of the copper inductance coil is changed by heating due to the current and other disturbing causes, so that when the galvanometer reading is observed the deflecting current is produced by an overbalancing resistance which differs from the small known resistance introduced. The change is usually sufficient to render results uncertain within 1 per cent. The method has been modified by the author by omitting this measurement with the

small known resistance and substituting for it the measurement of the current in the main circuit. The modified method presents for work of precision an advantage over all other known methods on account of a greater freedom from uncertain corrections. The mathematical relations involved are very simple. The Anderson null method has also been modified by the author so as to render effective the free charge only of the condenser; it is capable of as high a degree of accuracy as the modified Maxwell-Rayleigh method. The modification of the Anderson method by the employment of a secohmmeter gives results varying appreciably with the rate of the alternations of the current. F. E. S.

879. *Internal Resistance of Galvanic Cells.* W. Block. (Zeitschr. Phys. Chem. 58, pp. 442-448, March 15, 1907. Extract from first part of Inaug.-Dissertation, Königsberg.)—Three methods of measurement are considered: the Mance-Lodge, the Kohlrausch and Less, and that due to Nernst; these have been slightly modified by the author. The first of these methods is not suitable for precision measurements, as the measured resistance is markedly influenced by the current through the cell. In the latter two methods alternating currents are employed; the following measurements show that in practice they are reliable. The resistance of a Daniell cell in a circuit with 80 ohms external resistance was determined by the method of Less to be 1.501 ± 0.001 ohm; it was measured by Nernst's method, and the value assigned was 1.467 ± 0.002 ohm; again it was measured by the method of Less and found to be 1.487 ± 0.001 ohm. The mean of the first and third values is 1.469 ohms, agreeing remarkably with the second value. F. E. S.

880. *Daniell Cell.* W. Block. (Ann. d. Physik, 22. 8, pp. 505-518 March 5, 1907. Extract from second part of Inaug.-Dissertation, Königsberg.)—An investigation of some of the properties of current-furnishing Daniell cells. Two sizes of cells were used, and concentrated solutions of CuSO_4 and ZnSO_4 were employed. Observations extending over 24 hours were first made on the fall of potential at the terminals, when the circuit was completed through resistances varying from 500 ohms to 20 ohms; in some cases the cells were short-circuited for a few min. before the resistance was inserted. When the external resistance was great and there was no preliminary short-circuiting, the potential remained approximately constant after the circuit was made; under similar circumstances, but when the external resistance was from 100 to 20 ohms, the potential rose considerably for some hours; but when the cell was short-circuited as a preliminary, the potential was satisfactorily constant after 80 min. The internal resistance of the small cells varied from 0.9 to 1.4 ohms, and that of the large cells from 0.6 to 1.0 ohms. The temperature-coefficient was found to vary with the current; when the external resistance was ∞ , the temperature-coefficient per 1°C. was $+2 \times 10^{-4}$ volt; for an external resistance of 100 ohms it was $+5 \times 10^{-4}$ volt; and for 20 ohms external resistance it rose to $+28 \times 10^{-4}$ volt. The effect of polarisation was measured for many different currents; the collected results are as follows:—

External resistance	∞	400	200	100	40	20 ohms
Obs. No. I. ...	1.07895	0717	0709	0700	0696	0674 volt
II. ...	71	21	11	08	94 ₅	70 "
III. ...	70	22	10	08 ₅	98	65 "
Mean	1.0770	0720	0710	0702	0696	0669 "
Polarisation.....	0	0.0050	0.0060	0.0068	0.0074	0.0101 "

Experiments were also made with dilute solutions and with stirred electrolytes. In conclusion, a few remarks are made on the explanation of the observed phenomena.

881. *Thomson-effect and Temperature-coefficient of Thermal Conductivity in Soft Iron.* E. H. Hall, L. L. Campbell, S. B. Serviss, and E. P. Churchill. (Amer. Acad., Proc. 42, No. 23, pp. 597-626, March, 1907. Contribution from the Jefferson Phys. Lab., Harvard College.)—In a previous paper [see Abstract No. 1470 (1905)] the authors gave the results of certain measurements on the Thomson-effect, thermal conductivity, electric resistance, and "thermoelectric height" with copper of a certain specimen of soft iron. For the same specimen the following results are now added: Temperature-coefficient of thermal conductivity between 115° and 204° C., referred to the value of the conductivity at 115° = -0.00068 approximately. Electric resistance, absolute: 17,280 at 100° and 26,140 at 218.2° C., with a mean temperature-coefficient 0.00661 (on the basis of the 0°-value for the resistance) between 100° and 218° C. Thomson-effect coefficient, v [$= \sigma/T$ where σ is the fraction of a calorie absorbed per sec. in the Thomson-effect by a current of 10 amps. flowing from a cross-section at temperature $(T - \frac{1}{2})$ absolute to a cross-section at temperature $(T + \frac{1}{2})$ absolute] is $-[717 + 2(T - 805)] \times 10^{-10}$, from 82° C. to 182° C. The rate of change of v here indicated would make the tangent of the angle of inclination of the iron line on the ordinary thermoelectric diagram about 40 per cent. greater at 182° C. than at 82° C. It appears that there is general agreement among those who have worked directly on the Thomson-effect in iron that the line for this metal on the thermoelectric diagram should be one of increasing steepness from 50° C. to the neighbourhood of 180° C. The general arrangement of apparatus employed for the measurements and the difficulties met with are very fully described. F. E. S.

882. *Induction Coils.* F. Lori. (Atti dell' Assoc. Elett. Ital. 10, pp. 42-51, May, June, July, Aug., 1906.)—Investigates the arrangement of resistances, capacities, and inductances giving the greatest spark-length without danger of injuring the coil. An arrangement of discs and commutators is described by which the coil, provided with a closed magnetic circuit, is taken through a cycle, consisting of a current in one direction, a break, a maximum current in the opposite direction, a gradual diminution of this current to zero, and a current in the first direction. Sparks occur at make but not at break, and the coil is less likely to suffer. E. E. F.

883. *New Galvanometer.* J. K. A. Wertheim-Salomonsen. (Phys. Zeitschr. 8, pp. 195-198, April 1, 1907. Electrician, 59, pp. 68-64, April 26, 1907. Abstract, Écl. Electr. 51, pp. 179-180, May 4, 1907.)—The author refers to a modified form of Einthoven's chord galvanometer constructed by T. Place; in this the magnetic field in which the silvered quartz thread is stretched is produced by an auxiliary current passed through two parallel wires, stretched one on each side of the deflectable thread. An improved form has been constructed by the author, and illustrations are given of the instrument as well as examples showing its applications, sensibility, period, &c. As a galvanometer, the field-producing wires being supplied with current (1-20 amps.), the passage of a small current through the quartz thread deflects the latter in the usual way.

Conversely, by passing a known small current through the quartz thread, the strength of the current through the field-producing wires can be measured (< 40 amps.). The other uses are: (1) As electro-dynamometer, the same current being passed through the quartz thread and the field wires in series. (2) As wattmeter, the ampere and pressure currents being supplied to the field wires and the deflectable wire respectively. (3) As electrometer, the field wires not being joined, but each representing a pair of quadrants, and the deflectable thread being the "needle." As a galvanometer the sensibility is given as $1/250$ that of Einthoven's, hence about 1 mm. for 2.5×10^{-8} amp. As electro-dynamometer a current of 2×10^{-4} amp. can be measured. As wattmeter the sensibility is stated to be greater than the "mirror" wattmeters in general use, and the instrument has the advantage of having neither capacity nor inductance, besides having a very short period. As electrometer (idiostatic), with a 3μ diam. Wollaston wire as thread, 1 volt gives a deflection of 1 mm. (magnification 250) with a half-period of 0.12 sec., or with a 2-sec. half-period 0.25 volt; with the "quadrants" charged to 100 volts and the half-period reduced to 0.016 sec., $1/10$ volt can be read. With the Wollaston wire as loose as possible (half-period = 1 sec.), 1 mm. deflection is obtainable for 0.001 volt; with a quartz thread 1μ in diam. probably 100 times the sensibility. The length of "thread" employed was 11 cm. Two oscillograms are given.

L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

884. *Maximum Flux of Electromagnets.* M. Ascoli. (Elettricità, Rome, 6, pp. 88-84, Feb. 1, 1907.)—Points out that Johnston's rule, according to which maximum magnetic flux is obtained by making the diam. of the core two-thirds of the internal diam. is not correct. He calculates the flux in a closed magnetic circuit and in a cylindrical electromagnet by the method of Lamont and Frölich, and gives a graphical construction for maximum flux. In every case the value of the best ratio of the radius r of the core to the radius R of the winding depends upon the current density, the nature of the material, and the external diam. itself. In a closed magnetic circuit $r > \frac{1}{2}R$, and in practical cases it will probably approach or exceed 0.9R. In a cylinder $r < \frac{1}{2}R$, and in practical cases will be nearer $\frac{1}{2}R$. In other cases there will have to be intermediate values depending upon the width of the gap in the magnetic circuit.

E. E. F.

885. *Susceptibility of Mixtures of Salt Solutions.* J. C. McLennan and C. S. Wright. (Phys. Rev. 24, pp. 276-284, March, 1907. Paper read before the Amer. Phys. Soc., Dec., 1906.)—The attraction of the solution into the field of an electromagnet is measured by a weighing method, the solution being contained in a deep rectangular vessel. The susceptibilities of water and of solutions of salts of Mn, Cu, and Al were determined, the values found for the Al salts being very small, the sulphate and chloride giving negative (diamagnetic) values. Mixtures of Mn and Al salts behaved as if there were no Al salt present, but the addition of a copper salt to the mixture of the other two caused an increase of the susceptibility proportional to the amount of Cu added. It is evident, therefore, that the relations which the Mn and Al bear to each other are quite different from those which exist between them in the Heusler alloys, on the permeability of which the Al produces a very pronounced effect. [See also Abstracts Nos. 822, 2974 (1904), 1050, 1291, 1687, 2274 (1905), and 1921 (1906).]

G. E. A.

886. *Hall-effect in Heusler Alloys.* H. Zahn and H. Schmidt. (Deutsch. Phys. Gesell., Verh. 9. 6. pp. 98-108, March 30, 1907.)—The Hall and allied effects are greater in the magnetic than in other metals, with the exceptions of Te and Bi. The coefficients of the Hall and of the thermo-magnetic effects have been measured for a series of Heusler alloys; these are denoted by R and Q below. For comparison their values are given for the metals composing the alloys.

Metal.	$10 \times R \times 10^3$	$Q \times 10^3$
Heusler alloys	+1800 (approx.)	-500 (approx.)
Mn	-98	-15
Al	-40	+20
Cu	-50	+90

Temperature coefficient of R, + 0.008; temperature coefficient of Q, - 0.006. As the table shows, R and Q are considerably larger for the Heusler alloys than for the component metals.

887. *Variation of Terrestrial Magnetic Field with Altitude.* A. Senouque. (Comptes Rendus, 144. pp. 536-538, March 4, 1907.)—From observations of declination and dip made at stations of various altitudes in the neighbourhood of Mont Blanc (altitudes from 550 m. to 4,800 m.), the deviations of the theoretical values are derived, and the residuals then plotted against the altitudes as ordinates. The resulting curve comes out very nearly a straight line for both components. The decrease of the horizontal force for 1,000 m. elevation is 0.00021. In the dip there is a slight increase with the altitude, apparently indicating that the lines of force of the terrestrial magnetic field diverge more and more as the distance from the centre of the earth is increased. C. P. B.

888. *British Magnetic Elements.* W. Ellis. (Roy. Soc., Proc. Ser. A. 79. pp. 13-17, March 12, 1907.)—The paper gives a comparison of values of the magnetic elements, deduced from the British Magnetic Survey of 1891, with the results of more recent observations. In the preparation of maps showing lines of equal magnetic declination for commercial use from the data given in the Survey, it has of late years become apparent, by comparison with the observations made at the observatories of Greenwich, Kew, Stonyhurst, Falmouth, and Valentia, that, owing to decrease in value of the annual variation, the lines, as brought forward from the Survey, are now carried too far to the west, giving too small a value for the declinations, the discordance being apparently greater towards the west than on the eastern side. For detailed work, the continuous records available at the various magnetic observatories, combined with further magnetic observations, taken from time to time at a limited number of selected stations distributed over the area covered by the Survey, may give sufficient information, the local deviations being thus known, for rectification of the mean lines of equal values of the several magnetic elements. C. P. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

889. *Regulating the Vacuum in Röntgen-ray Tubes.* G. Berlemont, (Comptes Rendus, 144. pp. 795-796, April 15, 1907.)—An aluminium plate placed within the tube, near the kathode region, will, if it be connected to the kathode and a feeble current passed for 2 or 3 min., make the tube become very hard in quality. Conversely, if the Al plate be connected to the anode and the tube run in the ordinary way, the tube will gradually become softer in quality. An example is quoted. Thus a tube which after 50 hours' running became hard, with an equivalent spark of 15 cm., was reduced to 10 cm. equivalent spark in 6 min. In the reverse case, a tube showing 2 cm. equivalent spark was, after 6 min., brought up to a 10 cm. equivalent spark. The method depends upon the occlusion of hydrogen by the aluminium and its disengagement on the plate heating up when functioning as anode. L. H. W.

890. *Molecular Theory of Electric Properties of Nerve.* W. Sutherland. (Amer. Journ. Physiology, 17. pp. 297-311, Nov. 1, 1906.)—In a previous paper [see Abstract No. 245 (1906)] the author proposed the theory that the nerve impulse is propagated by a shear along nerves, and at the same time it was pointed out that, the elastic properties of matter being of electric origin, the electric properties of nerve were implicitly involved in the theory. In the present paper the connection between the elastic and the electric properties of nerve are explicitly shown by means of our knowledge of the proteid molecule and a theory of the structure of colloidal solids. The subject is treated in the following order: (1) The elastic properties of jellies and their structural cause; (2) the electric origin of rigidity in a jelly [see also Abstract No. 1781 (1904)]; (3) calculation of the electric charge required to stimulate a given nerve, viz., the sciatic nerve of a frog. The paper then concludes with various quantitative electric properties of nerve. E. H. B.

891. *Action of Röntgen Rays on Hæmoglobin in Vitro.* H. Bordier. (Archives d'Él. Médicale, 15. pp. 186-187, March 10, 1907. Paper read before the Assoc. franç. pour l'Avancement des Sciences at Lyons.)—A small quantity of blood contained in a porcelain dish was subjected to the action of the Röntgen rays. The specimen was previously diluted up to the point at which the two bands of oxyhæmoglobin could just be perceived spectroscopically. With this degree of dilution the methhæmoglobin band can be perceived when a very small quantity of the substance is present. During the exposure drops of blood were taken from the dish from time to time and examined, but the methhæmoglobin band did not appear even after an enormous dosage. The author, however, showed that when blood is exposed to the air for some time and water is added to that portion which has become desiccated and adherent to the dish, the resulting solution contains methhæmoglobin. This fact, he suggests, may be the explanation of the presence of this substance, demonstrated by V. Henri and A. Mayer [Abstract No. 1424 (1904)], in blood, which has been subjected to the action of radium rays for a prolonged period. H. W. P. Y.

REFERENCES.

892. *Electron Theory of Metals.* R. Schenck. (Metallurgie, 4. pp. 161-173, March 22, 1907.)—Gives an excellent résumé of the subject and references to the literature. R. S. W.

893. Electric or Magnetic Polarisation of a Thin Cylinder in a Uniform Field. **T. H. Havelock.** (Roy. Soc., Proc. Ser. A. 79. pp. 31-42, March 12, 1907.)—The problem here mathematically attacked is the calculation of the polarisation induced in a cylindrical rod of finite length by a uniform field of force parallel to its axis. The solution is obtained in the form of Bessel functions, and various other results are then deduced from it, such as the *total moment* on the rod and the *mean induction*. For magnetic induction the results of this theory give only limiting values towards which the quantities approach as the magnetisation tends towards saturation. [See also Abstract No. 886 (1902).] **E. H. B.**

894. Theory of Electrodeless Ring Discharge. **B. Davis.** (Phys. Rev., 24. pp. 224-226, Feb., 1907.)—A simpler and more complete method of calculating the electrical intensity at a point within a flat spiral coil carrying a varying current is given. The results of the previous research [Abstract No. 1478 (1905)] are not much altered. **R. S. W.**

895. Photographs of Lightning-flashes. **J. W. S. Lockyer.** (Photographic Journ., 47. pp. 8-12; Discussion, pp. 12-15, Jan., 1907.)—Under the title, "Thunderstorms and a Camera," reproductions of typical photographs which are to be sent to the New Zealand Exhibition by the Solar Physics Observatory are given. A suggested classification of the different types of flash is put forward.

896. Poulsen's so-called Undamped Oscillations. **G. Benischke.** (Elektrotechn. Zeitschr. 27. pp. 1212-1213, Dec. 27, 1906.)—Benischke points out that the oscillations obtained by Poulsen [Abstracts Nos. 1620 (1905) and 1473a (1906)] should be termed lasting (continuous) or forced oscillations since they are not actually undamped. **E. Ruhmer.** (Ibid. 28. p. 69, Jan. 17, 1907.)—Ruhmer considers the Poulsen arc to be no true Duddell arc and that the phenomenon is of the nature of the arc interrupter. **Benischke**, however (Ibid. pp. 69-70), does not agree with this view. **M. Reithoffer** (Ibid. pp. 308-309, April 4) gives his own explanation of the phenomena involved, and differs from Benischke in that he does not consider the magnetic field important. **L. H. W.**

897. Rapid Electric Oscillations in Stationary Media. **E. Kohl.** (Ann. d. Physik, 22. 3. pp. 401-428, March 5, 1907.)—On the basis of Maxwell's equations and Lorentz's extension by the conception of convection currents, the author here develops the mathematical theory of the dielectric displacements for rapid vibrations in stationary media, and, for the sake of generality, it is supposed that the displacements of the opposite electricities under the influence of a given field may differ in magnitude as well as in sense. The Michelson experiment is felt to be a difficulty, but the author hopes to clear that up eventually. [See also Abstract No. 1288 (1906).] **E. H. B.**

898. Magnetic Observatory of the German Antarctic Expedition, 1901-1903, at Kerguelen Island. **K. Luyken.** (Terrestrial Magnetism, 11. pp. 202-205, Dec., 1906. Paper read before the 15th Deutsch. Geographentag, Danzig, 1905. Translation.)—Descriptive. No results given.

899. Terrestrial Magnetic Potential. **V. Carlheim-Gyllensköld.** (Ark. för Mat. Astron. och Fysik, Stockholm, 8. 7. pp. 1-5, 1906.)—Development of the function of the earth's magnetic potential in terms of the time, with a table showing the provisional constants. **C. P. B.**

900. Recent Progress in Röntgen-ray Technique. **H. Lewis Jones.** (Elect. Engineering, 1. pp. 189-192, Jan. 31, 1907. Elect. Rev., N.Y. 50. pp. 316-317, Feb. 23, 1907. Abstract.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

901. *Absorption of Hydrogen by Metal Films.* W. Heald. (Phys. Rev. 24. pp. 269-275, March, 1907.)—It is found that when metals are vaporised in an atmosphere of hydrogen, the deposition of a thin film of metal on the walls of the tube is accompanied by an absorption of H, which proceeds for some time after the temperature has again fallen. An arc is formed between two metal electrodes: the pressure is measured by a McLeod gauge. The results are expressed in curves. Of the metals studied, Cd, Ag and steel give definite results; Al and Pt indicate marked absorption during deposition; Zn alone shows no absorption. R. S. W.

902. *Niobium: its Preparation and Properties.* W. v. Bolton. (Zeitschr. Elektrochem. 13. pp. 145-149, April 12, 1907. Engineering, 83. p. 527, April 19, 1907. Abstract.)—In the course of the search, by Siemens and Halske, for new lamp filaments, the author has prepared pure niobium, which differs considerably from the metal as so far described. The preparation resembles that of tantalum. The pentoxide of niobium is stirred with paraffin, and U-shaped threads are made of the mixture; at white heat the threads change into the tetroxide, which conducts the electric current; alternating currents then reduce the oxide to metal, when the oxygen is removed as it escapes. When larger masses of Nb are wanted, the pentoxide is heated with less than the amount of Al required for reduction; a hard alloy NbAl results, which Goldschmidt had mistaken for the metal; this alloy gives off its Al—and part of the Nb as well—when heated for many hours in a vacuum electric furnace, and pure niobium is left, standing as to appearance between tantalum and platinum. The pure Nb is soft (not hard as the hydride, mistaken by Roscoe and by Weiss and Aichel for the metal, and as the carbide which deceived Moissan); it can be rolled out to foil of density 12.75 (not 7.5, as previously assumed), but not so easily drawn out to wire; the metal is very difficult to oxidise, is not attacked by most chemicals, but combines with hydrogen, nitrogen (in ammonia), and sulphur. It is not suitable for lamp filaments, as the filaments melt soon, the melting-point being $1,950^{\circ}\text{C}$. Like aluminium and tantalum, niobium electrodes stop the anode current pulse in electrolytic cells. When alloyed with other metals, the niobium is dissolved by sulphuric acid together with the iron or other metal. H. B.

903. *Preparation of Barium; Reactions between the Alkaline Earths and their Metals.* A. Guntz. (Annal. Chim. Phys. 10. pp. 487-450, April, 1907.)—The preparation of barium (and also of strontium) has been explained in Abstract No. 597 (1906). The paper chiefly deals with the reactions between these metals and the alkaline earths, which the author studies in a tubular electric furnace. The commercial BaO always contains peroxide, BaO₂. When Mg and BaO interact at high temperature, the suboxide Ba₂O is formed which, being unstable, dissociates and yields Ba; the Ba alloys with Mg and also reacts on MgO. When BaO is placed on wire gauze above metallic Ba, the Ba volatilises and yields Ba₂O. Similar reactions take place between BaO and Ca, and the reduction of BaO by Ca is not practical, therefore. The reduction of BaO by Al succeeds, however, because the Al is not volatile at $1,100^{\circ}\text{C}$. H. B.

904. *A Development of the Atomic Theory.* W. Barlow and W. J. Pope. (Chem. Soc., Journ. 89, pp. 1675-1744, Nov., 1906.)—The fundamental conception of the theory is that each atom occupies an approximately spherical "sphere of influence," the different atoms in a crystal being held in position by the influence of an attraction of the nature of gravity, and a repulsion attributed to the kinetic energy of the atoms. The effect of the attraction is to bring the spheres of influence into contact with one another at a maximum number of points, and this close-packing is supposed to apply, not only to the atoms which constitute the molecule, but to the molecules which are homogeneously packed together in a crystal.

The assumption is made that the sphere of influence of an atom is proportional to its valency. Thus if in a benzene crystal groups of three atoms of hydrogen are to be replaced by nitrogen atoms to produce triphenylamine, $N(C_6H_5)_3$, without disturbing the system of close-packing which prevails in the benzene it is necessary that the total solid volume of the hydrogen and nitrogen should be equal, *i.e.*, that the trivalent nitrogen atom should occupy three times the space occupied by the monovalent hydrogen. In modification of this simple view it is added (1) that probably the atomic volumes are not exactly proportional to the whole numbers by which valency is usually represented, and that the different behaviour of, *e.g.*, chlorine, bromine, and iodine may be due to slight variations of atomic volume; (2) that the volume ratios of different elements may vary slightly with the conditions, *e.g.*, of temperature, giving rise to different types of combination, and (3) that in passing from compound to compound the absolute magnitudes of the spheres of influence may change considerably, though the relative magnitudes are only slightly affected. This is entirely different from the current view of atomic and molecular volumes. Thus whilst Kopp assumed that the increase of molecular volume in the ratio 77.4 to 180.2 in passing from bromine to tetrabromobenzene was due to the replacement of four atoms of hydrogen of volume 4×5.5 by four atoms of bromine of volume 4×27.8 , the authors assume that the volume of the hydrogen and bromine atoms or spheres of influence are equal, but that the introduction of four bromine atoms so far loosens the packing that the spheres of influence of both carbon and hydrogen expand in the ratio 77.4 to 180.2. In support of this theory the case of potassium and caesium sulphates is quoted; the molecular volumes are 64.91 and 84.58, but the axial ratios ($0.5727:1:0.7418$ and $0.5712:1:0.7581$) are substantially equal; it is inconceivable that this close adherence to the type of structure would survive if the increase in volume were wholly due to an increase in the dimensions of one of the constituent atoms; on the other hand, it would be a natural result if the relative volumes of the atoms are determined by their valencies, the latter being identical in the two compounds.

The chief importance of this remarkable paper consists in the fact that it offers for the first time a quantitative explanation of crystal structure. Thus the crystalline constants of benzene may actually be derived from a model in which carbon spheres of volume 4 and hydrogen spheres of volume 1 are built up in a close-packed homogeneous system. Many other examples are given, but for these the original paper must be consulted. T. M. L.

905. *Abnormal Melting-point Changes.* P. Rohland. (Bayr. Gewerbemuseum Nürnberg, Techn. Mitt. pp. 301-302, 1906. Chem. Centralblatt, 1, p. 1401, 1906.)—Aluminium when pure melts more readily than metal containing impurities. The change from the solid to the liquid condition takes

place slowly, with formation of an intermediate mixture of solid and liquid. The rise of the melting-point may be attributed either to the presence of compounds which have higher melting-points, such as Al with Si, Fe, Pb, or Cu, or else to the action of the metal itself on air. L. H. W.

906. Melting-points of Cryolite-Alumina Mixtures. F. R. Pyne. (Amer. Electrochem. Soc., Trans. 10, pp. 63-65, 1906.)—The author and Y. F. Hardcastle melt mixtures of powdered cryolite and alumina (calcined bauxite with 99.9 per cent. of Al_2O_3) in charges of 100 gm., put in graphite crucibles by means of coal gas, measuring the temperatures with thermo-couples of le Chatelier which turned brittle in the mixtures but seemed to indicate correctly. The cryolite melts at $1,000^\circ\text{C}$.; addition of alumina lowers the melting-point to 915°C . for a mixture containing 5 per cent. of Al_2O_3 ; on further addition of alumina the melting-point rises to $1,015^\circ$ for 20 per cent. of Al_2O_3 . There is a drop in the curve, however, for 10 per cent. of Al_2O_3 ; this mixture melts at 980°C . and may correspond to the compound $\text{Al}_2\text{O}_3 \cdot 4(\text{AlF}_3 \cdot 3\text{NaF})$. The temperatures were determined during the cooling of the fused mass, when readings were taken every 15 sec. H. B.

907. A Nickel-Tin Compound. E. Vigouroux. (Comptes Rendus, 144, pp. 712-714, April 2, 1907.)—By the alternate action of hot nitric acid and fused caustic potash and finally washing with dilute nitric acid, the author obtains crystals of NiSn from alloys containing from 66.76 to 100 per cent. of Sn. A mixture of filings of Ni and Sn in the proportion of 1:2 combines with incandescence when heated slightly above the melting-point of Sn, and the above-mentioned crystals can be readily obtained from the resultant ingot. [See also *ibid.*, March 18, 1907.] F. R.

908. Alloys of Tin, Lead, Bismuth, and Cadmium. A. Stoffel. (Zeitschr. Anorg. Chem. 53, 2, pp. 187-188, April 4, 1907. From the chem. Laborat. d. Univ., Amsterdam.)—An investigation of the binary and ternary alloys of these metals. Pb and Sn form mixed crystals to a limited extent only, so also do Sn and Cd. In the cooling of Sn and Cd alloys there is a critical point at 125° (the eutectic being at 177°), which probably corresponds to the formation of Sn_2Cd . The ternary system Sn-Pb-Cd has a eutectic at 145° , of the composition 57 Sn, 21 Pb, 22 Cd in atoms per cent. There is a critical point between 118° and 112° , which decreases in importance with increasing Pb content, and no doubt corresponds to the formation of Sn_2Cd . In the ternary system Sn-Cd-Bi the eutectic occurs at 108° , with 33.2 Sn, 39.3 Bi, 27.5 Cd, in atoms per cent. The critical point in these alloys corresponding to the formation of the compound Sn_2Cd —which occurs throughout the series—is lowered by increase of Bi, to about 100° , the Bi and Sn_2Cd probably forming mixed crystals. Through a certain range there is in consequence no eutectic, the Bi-rich alloys apparently consisting of Bi + Cd + mixed crystals of Bi with Sn_2Cd . The greater portion of the alloys show a further critical point at 78° to 68° , which perhaps corresponds to the formation of a ternary compound. F. R.

909. Nickel-Tin Alloys. L. Guillet. (Comptes Rendus, 144, pp. 752-753, April 8, 1907. Extract.)—These metals form the following solid solutions and compound: α , solid solution from 0 to 5 per cent. Sn, which may be either magnetic or non-magnetic; β , solid solution, from 38 to 41

per cent. Sn; γ , solid solution, from 55 to 60 per cent. Sn.; the compound NiSn forming fine macroscopic crystals. α and β form a eutectic, and γ and Sn form another eutectic. Only the alloys containing less than 38 per cent. Sn are magnetic at the ordinary temperature. All of the alloys containing less than 48 per cent. Sn have critical points corresponding to the change from the non-magnetic to the magnetic condition. The only alloys of the series which have any industrial interest are those near the ends—Sn containing small amounts of Ni is harder than pure Sn, and can be mechanically treated equally well; Ni containing moderate additions of Sn is, similarly, better than pure Ni.

F. R.

910. *Nickel-Arsenic Alloys*. K. Friedrich. (Metallurgie, 4. pp. 200-216, April 8, 1907. Communication from the metallog. u. metallurg. Laborat. d. kgl. Bergakad., Freiberg.)—The experiments of the author and F. Bennigson show that in the temperature-concentration diagram for these alloys in the region 0 to 57.4 per cent. As there are 15 fields. The two maxima corresponding to the compounds Ni_3As_2 and NiAs occur at 998° and 968° respectively. Ni_3As_2 changes between 998° and 950° from an α to a β modification. At 898° , between 5.5 and 33.5 per cent. As, the eutectic of mixed crystals of Ni and As, with unsaturated mixed crystals of $\beta \text{Ni}_3\text{As}_2$ and Ni , is formed. At 804° , between 35.7 and 55.7 per cent. As, the eutectic of mixed crystals of Ni_3As_2 and As, with NiAs , is formed. The possible existence of Ni_2As_3 is also indicated, and a hypothetical line at about 715° is introduced for its formation, below which the alloys consist, according to their percentage of arsenic of (a) mixed crystals of Ni_3As_2 and As, + Ni_3As_2 , or (b) NiAs + Ni_3As_2 . The alloys show no special tendency to segregation. The maximum hardness occurs in the neighbourhood of the compound Ni_3As_2 , and in this region only the alloys are decidedly coloured. Only alloys with less than 29 per cent. As are magnetic.

F. R.

911. *Iron-Arsenic Alloys*. K. Friedrich. (Metallurgie, 4. pp. 129-137, March 8, 1907. Communication from the metallog. u. metallurg. Laborat. d. kgl. Bergakad., Freiberg.)—Presents the solidification diagram of alloys containing from 91.6 to 44 per cent. Fe. Five different bodies separate. Little can yet be said with certainty about one which occurs with over 70 per cent. Fe, and another at about 48.8 per cent. Fe, but the three compounds Fe_3As , Fe_2As , and FeAs were recognised. The occurrence of Descamps Fe_3As could not be verified. These alloys show no special tendency to segregation. There is marked brittleness in the alloys corresponding to Fe_3As , Fe_2As , and FeAs , but in hardness and colour these alloys differ but little from one another. Alloys with less than 60.1 per cent. Fe (corresponding to Fe_3As) are not appreciably magnetic. Photomicrographs of the series are given.

F. R.

912. *Freezing and Thermal Transformations of Iron-Carbon Alloys*. (II. and III.) P. Goerens. (Metallurgie, 4. pp. 137-149, March 8, and pp. 178-185, March 22, 1907. Communication from the eisenhüttenmänn. Inst. d. kgl. techn. Hochschule, Aachen.)—An exposition of experimental evidence in support of the view that all iron-carbon alloys are to be regarded as alloys of iron and iron-carbide, any free carbon found in the alloys being a decomposition-product of solid iron carbide. On the view of Heyn, the alloys may exist as either iron-ironcarbide (cementite) systems, or as iron-carbon

(graphitic) systems, the former being metastable and the latter stable, each system possessing a theoretically independent "equilibrium" diagram. The author examines these two diagrams by the aid of observations of the melting-points of some of the alloys. In white iron of nearly eutectic composition (4.8 per cent. C) he finds that the melting-point and freezing-point are identical, as would be anticipated in a true eutectic. In the fusion of grey iron (graphitic), however, the author confirms the fact that the melting-point is always considerably higher than the freezing-point or the melting-point of white iron of similar composition, and this fact does not agree with the theoretical formation of a true eutectic, consisting of saturated solid solution of C in iron plus graphite; the higher melting-point is explained on the view that cementite must first be formed before the metal can melt. The author also studies the mode of solidification of a variety of grey iron produced in the Girod electric furnace, containing 7.5 per cent. of total carbon. The microstructure shows the graphite in this iron to be uniformly distributed, and this cannot be readily explained on the view that the graphite has crystallised as such from the liquid, since in that case the graphite would have been driven upwards by the liquid metal; the microstructure further shows a graphite-free zone surrounding each of the large "primary" graphite crystals in this iron, and this also the author regards as contrary to the graphite-eutectic theory, as on that theory the primary graphite should be embedded in the eutectic without any intervening zone. The author considers that in hyper-eutectic irons solidification always begins by the formation of cementite crystals, and if the rate of cooling be rapid enough these remain as such, embedded in the solid solution plus cementite eutectic afterwards formed; on slower cooling, however, the primary cementite crystals decompose into graphite, which crystallises inside a shell of carbon-free iron, which latter is solid at that temperature. If the cooling is slow enough this iron will take up carbon from the surrounding fluid iron, until the shell enclosing the graphite again melts, the graphite thus freed rising to the surface as "kish." The same process of decomposition occurs also with the cementite of the eutectic, if cooling be slow enough. Section III. deals with the transformations of graphitic and cementitic irons under varying thermal treatment, annealing and quenching at various temperatures being studied in detail, the resulting micro-constituents being examined by means of various reagents, as suggested by Kourbatoff. All the constituents found in hardened, tempered and annealed steel are found and identified, and the general view of the author, that all graphite results from the decomposition of solid cementite, is considered to be fully borne out by the results of this investigation. For micrographic details reference should be made to the original paper, which is fully illustrated. [See also Abstract No. 975 (1906).]

913. *Method for producing Spongy Reduced Iron.* (Fr. Pat. 865, 878.)—

In F. C. W. Timm's process CO_2 is reduced to CO by passing through incandescent coke; the hot CO then passes through the ferriferous mineral which is to be reduced. Half of the resulting CO₂ is used over again similarly. The CO producer becomes too cold after about 10 min. Another is then used in its place, whilst the first is heated by blowing air through it at such a rate as to produce CO mainly, which is then made to heat the CO on its way to the chamber containing the mineral, or else to heat the chamber itself.

F. R.

914. *Influence of Solvents on the Rotation of Optically Active Compounds. IX. A New General Method for Studying Intramolecular Change.* T. S. Patterson and A. McMillan. (Chem. Soc., Journ. 91. pp. 504-519, March, 1907.)—The isomeric changes which substances like benzaldoxime and anisaldoxime undergo in solution can be rendered visible by dissolving them in an active solvent such as ethyl tartrate. The rotatory power of this substance is affected in an entirely different way by the two isomers, and the course of the isomeric change can be followed by means of the polarimeter, the mutarotation curves being precisely similar in form to those obtained when an active compound undergoes isomeric change in an inactive solvent. T. M. L.

915. *A Substance which exists in several different Liquid Phases.* F. M. Jaeger. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 845-848, Nov. 7, 1906. Proc., 9. pp. 859-862, Nov. 22, 1906.)—The substance, cholesteryl cinnamate, $C_{27}H_{48}O_2 \cdot C_6H_5 \cdot CH:CH:C_6H_5$, was prepared by melting together cholestrol and cinnamyl chloride at 190° . It is a well-crystallised substance of melting-point 155.8° , but melts to a doubly refracting liquid-crystal which gradually becomes thinner in consistency and clearer up to 199.5° . At this point, instead of becoming quite clear, it suddenly becomes enamel-white and rapidly thickens whilst still remaining doubly-refracting. A separation into two liquid layers is also observed, and both of these are anisotropic (i.e., liquid crystalline); on heating slowly the liquid phase then becomes isotropic, clear, and colourless at 201.3° . [See also Abstract No. 525 (1907).] T. M. L.

916. *Cuprous Sulphate.* F. Foerster and F. Blankenberg. (Ber. Deut. Chem. Gesell. 39. pp. 4428-4486, 1906. Chem. News, 95. p. 59, Feb. 1, 1907. Abstract.)—When copper is taken up by cupric sulphate to form cuprous sulphate the final equilibrium may be represented by the equation $2Cu \rightleftharpoons Cu + Cu$, and according to the law of mass action $c^2/C = \text{const.}$, where C = cupric concentration, c = cuprous concentration. Assuming cuprous sulphate to be completely dissociated and cupric sulphate 17 per cent. dissociated, the constant has the value 0.66×10^{-6} , in an acid solution, but increases as the temperature rises. If the solution is neutral the cuprous salt is partially hydrolysed $Cu_2SO_4 + H_2O \rightleftharpoons Cu_2O + H_2SO_4$, and a larger proportion of cuprous salt is formed than in a solution in which the acid necessary for equilibrium was initially added. It will be noticed that the cuprous concentration increases with the cupric concentration, though not proportionally. Cuprous sulphate has hitherto only been known as a minor constituent of a cupric solution; the authors have made a great advance by isolating crystalline cuprous sulphate in the form of an ammonia compound $Cu_2SO_4 \cdot 4NH_3 \cdot H_2O$, the method adopted being to enclose ammonium cupric sulphate with metallic copper in sealed tubes. The salt is unstable, but when quite dry can be kept for some weeks in sealed tubes at ordinary temperatures; with dilute sulphuric acid the crystals turn bright red and give metallic copper and cupric salt. A crystalline compound of cuprous chloride and ammonia has also been isolated. It is of interest to note that a solution containing initially 0.05 mol. $CuSO_4$, 0.95 mol. NH_3 , and 0.15 mol. $(NH_4)_2SO_4$, became quite colourless when saturated with metallic copper, and when electrolysed gave a cathode deposit 55 per cent. greater than that obtained from a cupric solution in series. T. M. L.

917. ψ -Surface for Binary Mixtures. J. D. van der Waals. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 540-544, Jan. 11, 1907. Proc., 9. pp. 524-528, Feb. 21, 1907.)—Examination is made as to the direction of the tangent at the plaitpoint of a binary mixture. For the analysis reference must be made to the actual paper, but it appears that if, with the author's usual notation, m/b is defined as the limiting density, the gas phase can be specifically heavier than the liquid phase when the more volatile substance has the greater limiting density. For helium the limiting density is probably equal to that of the heavy metals. Kamerlingh Onnes' observation of a gas that sinks in a liquid [see Abstract No. 274 (1907)] is thus in agreement with theory. R. E. B.

918. van der Waals' ψ -Surface. XIV. H. Kamerlingh Onnes and Miss T. C. Jolles. (Konink. Akad. Wetensch. Amsterdam, Versl. 15. pp. 659-667, Feb. 6, 1907. Proc., 9. pp. 664-672, March 28, 1907. Supplement 14 to the Communications from the Phys. Lab., Leiden.)—The graphical deduction of the results of Kuenen's experiments on mixtures of ethane and nitrous oxide (mixtures of the II type) by the aid of van der Waals' free-energy surface is here attempted. The models of the ψ -surfaces used were counterparts of those employed in examination of Kuenen and Hartmann's results for mixtures of carbonic acid and chloroform, and the connode and tangent chords were obtained by rolling a glass plate upon them. The results cannot be discussed apart from the diagrams, of which there are 12, but on the whole the construction agrees very satisfactorily with the observations, the greatest divergence occurring near the critical temperature. The transverse plait is shown to contract with rise of temperature and finally to split up into two plaits. R. E. B.

919. Calculation of Vapour Densities of Dissociated Substances. O. Brill. (Zeitschr. Phys. Chem. 57. pp. 721-738, Feb. 12, 1907. Inst. f. physikal. chemie, Berlin, July, 1906.)—The author derives from Nernst's work the following formula:—

$$\log \frac{\Delta(2D - \Delta)}{(\Delta - D)^2} = -\frac{Q}{4.571T} - 1.75 \log T + \log P + E_0C,$$

where Δ is the vapour density without dissociation, D the actual vapour density, Q the heat of dissociation, C the chemical constant of reacting molecules. The few experimental results which are sufficiently extensive and accurate are reviewed, and the values of Q_0 and E_0C are found. All the values of E_0C lie between 2.1 and 3.7 with the exception of bromine, for which it is 1.7. Putting $E_0C = 3$ as a mean value, and $x = 0.5$ for the degree of dissociation, values are calculated for T and compared with the experimental values with satisfactory agreement. For heterogeneous systems the equation—

$$\log p = (-Q/4.571) + 1.75 \log T + C$$

is applied to carbonates and nitrates, and found to give satisfactory agreement for the dissociation temperatures. [See Abstract No. 2002 (1905).]

H. H. F. H.

920. Oxidation of Nitrogen by the Silent Discharge through Air. E. Warburg and G. Leithäuser. (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 12.

pp. 229-234, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—Hautefeuille and Chappuis observed in 1881 that the silent discharge passing through mixtures of oxygen and nitrogen produced ozone and a nitrogen oxide, pernitric acid N_2O_5 , characterised by strong absorption in the visible spectrum. Continuing their researches [see Abstract No. 1645 (1906)] the authors find that a nitrogen oxide with this characteristic absorption, for which they propose the designation Y, is formed whenever dry oxygen acts on N_2O_5 ; the silent discharge is not essential. The N_2O_5 is prepared after Helbig by letting ozone act on N_2O_4 , generated from lead nitrate; the N_2O_5 is condensed at $-79^\circ C.$, its temperature raised to -18° or 0° , and a current of ozone passed over it. The resulting gas is examined for absorption in a tube of 80 cm. length, when 15 absorption bands are seen, against the 8 described by Hautefeuille and Chappuis, who worked with evidently less concentrated Y-gas in a tube 2 m. in length. The absorption is maximum at $60^\circ C.$, but the gas is soon decomposed by heat; it disappears at -79° , when a snow is condensed on the walls of the tube, the remaining gas not showing any absorption. The absorption also disappears when the Y-gas is passed through sulphuric acid or over phosphorus pentoxide, and further on addition of water vapour to the Y. Particulars of the spectrum are given; it resembles the spectrum of ozone of Ladenburg and Lehmann [see Abstract No. 1859 (1906)], whose oxygen, the authors suggest, was probably not pure. The formula N_2O_5 is not confirmed. Together with the Y disappears in the course of time also the ozone. H. B.

921. *Galvanic Aluminium-Magnesium Cell.* H. T. Barnes and G. H. Cole. (Amer. Electrochem. Soc., Trans. 10, pp. 55-59; Discussion, pp. 59-61, 1906.)—H. M. Tory and H. T. Barnes had observed [Abstract No. 1852 (1904)] that when two electrodes of the same metals are immersed in water, and the water surrounding the one electrode is charged with oxygen or air, this electrode becomes the cathode; in water charged with hydrogen different metals behave differently. The authors now study electrodes of Al and of Mg in water, free from or charged with oxygen, by the aid of hydrogen peroxide. Two Al-electrodes give 0.8 volt, two Mg-electrodes 0.02 volt, when only the one electrode stands in oxygen water; a Pb-Al couple gives 0.8 volt in gas-free water, and no p.d. when oxygen is present. Couples of Al and Mg immersed in solution of alum charged with oxygen yield 1.2 or 1.4 volts; when the cell is short-circuited the pressure rises to 2 volts; after drawing current for 10 min. the voltage drops, to rise again on adding fresh peroxide. Bent electrodes of large surface are applied; the ampere-hour efficiency of the couple is 64 per cent., the current waste owing to oxidation of the Mg 18 per cent. During the discussion, in the absence of the authors, M. Löb suggested that two effects were superposed; there was an H-O couple, and further a cell composed of the hydroxides of Al and Mg, which tended to combine to spinel. Bancroft referred to the apparent concentration cell $Ni/NiSO_4/Ni$ of Carhart, which had really proved to be an oxygen cell. H. B.

922. *Influence of Pressure on Synthesis of Ammonia by the Electric Spark.* E. Briner and E. Mettler. (Comptes Rendus, 144, pp. 694-697, March 25, 1907.)—The amount of ammonia produced may be considerably increased by plunging the tube in which it is formed into liquid air, whereby the ammonia gas is condensed and withdrawn from the destructive action of the spark. Working in this way, the authors have determined the yield of ammonia per kw.-hour, obtained by sparking a mixture of dry hydrogen and nitrogen

under pressures of from 20 to 800 mm. of mercury. The amount of ammonia formed rises rapidly at first with increase of pressure, rising from 0.12 gm. per kw.-hour at 20 mm. to a maximum of 0.16 gm. at 100 mm., but any further increase of pressure considerably reduces the yield. W. H. St.

923. *Electromotive Force of Iron under Different Conditions, and the Influence of Occluded Hydrogen.* T. W. Richards and G. E. Behr, Jr. (Zeitschr. Phys. Chem. 58. pp. 801-849, March 5, 1907. Contribution from the Chem. Lab. of Harvard College. Translation.)—The authors have determined the e.m.f. of iron—after various treatment—against a solution of ferrous sulphate. It was found that iron, reduced by hydrogen, gave, after some time, a constant value for the e.m.f., and the same value was obtained even after the iron was subjected to a pressure of 850,000 kg. per sq. cm. The authors also show, in opposition to other investigators, that the change in free energy produced by tensile stress must be very small. Iron reduced at a low temperature has an e.m.f. greater by at least 0.02 volt than fused iron. Assuming the value 0.56 volt for the normal calomel electrode, the e.m.f. of compact iron is 0.15 volt, and spongy 0.17 to 0.18 volt against normal ferrous sulphate. These values are not essentially altered by heating and sudden cooling. It is shown that finely-powdered iron, reduced at a low temperature, takes up hydrogen, but the e.m.f. is not thereby affected. On quenching iron in water, hydrogen is taken up in an active state and raises the electrode potential by 0.15 volt. Hydrogen thus occluded appears to be in every way the same as that absorbed by iron in presence of nascent hydrogen. The authors put forward the view that the hydrogen is dissociated but not ionised. A. F.

924. *Potential Gradients on Aluminium Anodes.* G. Schulze. (Ann. d. Physik, 22. 3. pp. 548-558, March 5, 1907. Communication from the Physikal.-Techn. Reichsanstalt. Écl. Électr. 51. pp. 176-179, May 4, 1907.)—The author [see Abstract No. 156. (1907)] had come to the conclusion that the aluminium anode of electrolytic cells becomes covered with a film of oxygen over which a much thicker skin of solid oxides spreads. In estimating the thickness of the film, from capacity measurements, the dielectric constant of the gaseous oxygen had been assumed to be approximately unity. If the film were gaseous, however, the sudden reduction of an electric pressure from 400 volts to 4 volts should diminish the gas pressure from 2,100 to 0.21 kg./cm.², and the gas should therefore expand more than a hundredfold, leading to a decrease in the capacity. The renewed capacity tests were conducted, not by the Maxwell-Thomson method so far employed, in which the condenser is short-circuited during each period, but by a modified method giving unidirectional current pulses. A slight increase in the capacity was noticed when the voltage was reduced; the film of oxygen must be in a very highly condensed condition, which a difference of a few thousands of atmospheres would hardly influence. The potential gradient in this film of dielectric constant 1.4 would be about 8,000 volts/ μ in the thinnest films, and 4,500 volts/ μ in films of a thickness of 100 μ . When the gas film is active, i.e., the Al anode and the electrolyte kathode, the conduction of electricity through the film cannot be effected by the electrons, since electrolytes do not contain free electrons; it must be the ions which carry the electricity, and the ions require a very high potential gradient to pass through the film. When the gas film is inactive, i.e., when the cell does not act as electrolytic valve, and the Al is kathode, the free electrons of the Al carry the current through the gas film under a potential

gradient which corresponds to that which Earhardt and Hobbs found independently for sparking-potentials at very small distances. These potentials do not depend upon the gaseous medium and its pressure, but on the electrode material, and the gradient is for Al 105 volt/ μ , while in the active cell the gradient ranges from 4,500 to 6,800 volts/ μ . Two experiments support this view. When an insulated piece of metal (Pt) is dipped into the electrolyte and brought quite close up to the Al-anode, sparks pass over to the metal, and the potential falls to a few volts, to rise to its original value as soon as the metal is removed again. When the electrolyte in the cell is replaced by mercury, sparks pass through the solid skin, which is a fairly good conductor of electricity, and the film, and the p.d. between the Hg and Al falls to zero, showing that there is actual contact. The voltage required to make the sparks pass depends upon the length of the formation period, during which the solid skin, but not the gaseous film, becomes thicker. H. B.

925. *Electrolytic Rectification of Alternating Currents.* J. Šebor and L. Šimek. (Zeitschr. Elektrochem. 18. pp. 118-115, March 29, 1907. From Ber. d. k.k. böhm. Akad., p. 40, June 22, 1906.)—Experiments on four small cells, with electrodes of aluminium and lead, each of 10 cm.² area, proved that the greatest rectification efficiency was attained with potassium bichromate as electrolyte—the other electrolytes used were sodium bicarbonate, sodium phosphate, and sodium bichromate—although the highest voltage was attained with sodium phosphate. Experiments on larger cells (plates 17 × 80 cm., and an electrolyte of 2 per cent. sodium bicarbonate and 2 per cent. sodium phosphate) showed that better results were obtained with horizontal than with vertical electrodes. The condenser action depends on the kind of alternating current used, and is the cause why the voltage is so different on open circuit from what it is when direct current is being taken from the cell. The authors, using a condenser system made up of two Al plates in sodium phosphate solution, further show that the capacity of such condensers does not change with varying potentials, if the latter are not too near those at which the condenser breaks down, i.e., too near the critical potential. The results of experiments with Al containing various impurities, using direct currents, show that the purity of the Al has a great effect on the critical potential, although the effect varies with the electrolyte used. Impurities such as Mg and Sb, which elements have a rectifying action similar to that of Al, do not have a very great influence. The conductivity of the electrolyte used is of subsidiary importance compared with the nature of the electrolyte. T. S. P.

926. *Electrolysis of Alkali Chlorides with Alternating Currents.* II. A. Coppadoro. (Gazzetta Chim. Ital. 86. 2. pp. 821-828, 1906.)—The formation of chlorate by the electrolysis, with a current of 42 alternations per sec. passing between platinum electrodes, of solutions of alkali chlorides at 50-70°, does not take place unless the current density exceeds 100 amps./cm.². Increase of the current density is accompanied by increase of the current yield, which, however, never exceeds 15 per cent., even at a density of 400 amps./cm.². As the electrolysis proceeds the current yield diminishes, but does not become zero unless the current density is below 250 amps./cm.². The yield is raised and maintained for some time above 10 per cent., if a small quantity of alkali chromate or carbonate is added to the chloride solution. During the formation of chlorate, the platinum electrodes undergo considerable disgregation. [See also Abstract No. 1648 (1906).] T. H. P.

927. *Electrolysis of Molten Sodium Nitrate.* C. Couchet and G. Némirowsky. (Zeitschr. Elektrochem. 18. pp. 115-117, March 29, 1907.)—In the electrolysis of fused sodium nitrate the best yields of nitrate and oxide are obtained with graphite electrodes. Rise in temperature, or increase in the current density, gives a better yield, and direct current is better than alternating. An increase in voltage diminishes the yield. Superimposed on the action of the current is the reducing action of the powdered graphite formed from the electrodes during electrolysis. T. S. P.

928. *Anodic Behaviour and Passivity of Copper in Caustic Soda.* E. Müller. (Zeitschr. Elektrochem. 18. pp. 133-145, April 12, 1907.)—The perfectly bright copper electrode is, in caustic soda of different concentrations, first active as to the formation of Cu^+ and of cuprous oxide. As this oxide is little soluble, the electrode turns passive for this first stage, but active for the formation of Cu^{++} and of oxide; the first stage the author indicates by I-active, the second by I-passive-II-active. When the electrode has become covered with oxide, it turns passive a second time, but remains active as to the formation of peroxide or the generation of oxygen; this stage is the I-II-passive-III-active stage of the author. The electrode never turns I-II-III-passive. The I-passivity does not mean that no cuprous oxide is formed at all, but only that the quantity of this oxide remains constant. H. B.

929. *Electrolytic Preparation of Amalgams.* G. McP. Smith and J. R. Withrow. (Amer. Chem. Soc., Journ. 29. pp. 321-324, March, 1907.)—The authors use the method of Shepherd [Abstract No. 1121 (1903)] for the preparation of amalgams of sodium, potassium, barium, strontium, calcium, and lithium. None of the amalgams, with the possible exception of the potassium amalgam, were pure; they all contained more or less potassium, which was probably derived from the porous pot used. It seems as if the difficulty in making solid amalgams of the alkali and alkaline earth metals by electrolysis increases inversely as the atomic weights of the metals. [See also Abstract No. 1292 (1903).] T. S. P.

930. *Electrolytic Deposition of Nickel-Zinc Alloys.* E. P. Schoch and A. Hirsch. (Amer. Chem. Soc., Journ. 29. pp. 314-321, March, 1907.)—When an alloy of nickel and zinc is deposited from a solution containing an excess of nickel, it is found to contain more zinc than nickel, although the electrolytic solution pressure of zinc is greater than that of nickel. The proportion of zinc in the deposit is greater, the greater the proportion of zinc in the electrolyte; it also increases with the current density, and approaches asymptotically to a maximum. The ratio of zinc to nickel (in equivalents) in the alloy is from 4.5 to 14 times their ratio in the electrolyte, and depends on the concentration of the latter. The authors offer no explanation of their results. T. S. P.

931. *Rapid Determination of Copper Sulphate and Sulphuric Acid in Galvanoplastic Baths.* A. Wogrinz and J. Kittel. (Chem. Zeit., 80. pp. 1800-1801, 1906.)—Hydrogen sulphide is passed in the cold through a measured quantity of the bath-liquor, placed in a measuring flask, and when all the copper is precipitated, the excess of H_2S is blown out and the flask filled to the mark. After allowing to settle, an aliquot part of the solution is filtered through a dry paper and titrated with sodium hydroxide using

methyl orange as indicator, the result giving the total free and combined acid. The free acid is determined by direct titration of the solution with sodium hydroxide using Congo paper, and the difference between the two results represents the copper salt present. W. H. St.

932. Rapid Electroanalytical Deposition and Separation of Metals. Part I. Metals of the Silver and Copper Groups and Zinc. H. J. S. Sand. (Chem. Soc., Journ. 91. pp. 878-410, March, 1907.)—The author has designed a special apparatus for the rapid electro-deposition of metals. Rotating electrodes are used, and by the employment of an auxiliary electrode—mercury-mercurous sulphate-2-N sulphuric acid—the potential at which the metal is deposited at the kathode can be regulated, so that separations can be carried out by the method of graded potential. The conditions necessary for obtaining adherent metal deposits are discussed, and it is pointed out that the special advantage of the auxiliary electrode is that the potential of the kathode can be so regulated that it is always kept below that necessary for the deposition of hydrogen or the formation of a hydride. In the experimental part the conditions for the quantitative deposition of each metal are given, and then the methods of separating two or more metals from each other in solution. The separations described are: Mercury and silver; copper and mercury; copper and silver; bismuth and copper; lead and silver; lead and bismuth; cadmium and bismuth; zinc and cadmium; lead, cadmium, and zinc; copper, bismuth, lead, and cadmium; silver, mercury, copper, bismuth, lead, cadmium, and zinc. Silver was deposited from boiling ammoniacal and acetate solutions; with boiling solutions silver peroxide is not deposited on the anode. Lead was generally deposited as metal from solutions containing tartaric acid or glucose. Satisfactory deposits of bismuth were obtained from acetate, tartrate, and nitrate solutions, the only conditions which had to be observed being to keep the potential of the kathode as low as possible. The times necessary for deposition were very short, e.g., silver is separated from copper in about 6 min. from boiling acetate solutions. The accuracy attained is shown by the following results.

	Ag. + Hg.	Ag.	Cu.	Bi.	Pb.	Cd.	Zn.
Taken...	0.2244	0.1078	0.8682	0.1554	0.1424	0.0988	0.1287
Found...	0.2249	0.1098	0.8682	0.1548	0.1448	0.0985	0.1311

The total time taken in carrying out the separation was 110 min. T. S. P.

933. Electrolytic Estimation of Antimony. J. M. M. Dormaar. (Zeitschr. Anorg. Chem. 53. 8. pp. 849-860, April 17, 1907. Van't Hoff Laborat., Utrecht, Jan., 1907.)—The electrolytic deposition of antimony from solutions of the complex thio-salts gives too high results. The excess (2-3 per cent.) of the experimental over the theoretical results increases with the current strength and also with the concentration of the solution. The greater part of the excess is due to the presence of oxygen, as was shown by the reduction of the deposited metal with hydrogen, the remainder being caused by the inclusion of sulphur compounds from the electrolyte. The oxidation of the metal is not brought about by atmospheric influences, but appears to be inseparable from the electrolytic processes which go on. T. S. P.

934. Quantitative Separation of Tin from Manganese, Iron, and Chromium by Electrolysis. N. A. Puschin. (Zeitschr. Elektrochem. 18. pp. 158-164,

April 19, 1907. Elektrotechn. Inst., St. Petersburg. Translation.)—Using solutions containing the acid oxalates, tin can be electrolytically separated from Mn and Cr. During the electrolysis oxalic acid must be added to keep the electrolyte acid. In the case of iron and tin the separation is not quantitative, being complicated by the cathodic reduction of ferric to ferrous salts. With Mn and Sn the voltage must not be greater than 8, and the highest permissible current density is 3–4 amps. per dm.². In the case of chromium and tin the separation offers no difficulties; the voltage may be 2.5–4, and the current density as high as 5 amps. per dm.², when the electrolyte is stirred. [See also Abstract No. 1492 (1906).] T. S. P.

REFERENCES.

935. *A Classification of the Elements on the Basis of Atomic Volumes and Combining Weights only.* J. Monckman. (Chem. News, 95. pp. 5–9, Jan. 4, 1907.)—Lothar Meyer's curve connecting atomic volumes with combining weights is differentiated, the tangents dV/dW being replotted against the combining weights W . A series of curves are thus obtained in which many of the periodic properties of the elements are effectively displayed, but for details of these the original paper should be consulted. T. M. L.

936. *Atomic Weights of the Rare-earth Elements.* W. Feit and K. Przibylla. (Zeitschr. Anorg. Chem. 50. 3. pp. 249–264, Aug. 31, 1906. Laborat. d. kgl. Berginspektion, Vienenburg, July, 1906.)—By dissolving known weights of the oxides in excess of standard sulphuric acid and determining the excess of acid by titration with alkali solution, the following atomic weights are obtained: Lanthanum, 139.17; praseodymium, 140.62; neodymium, 144.60; samarium, 150.66; europium, 152.66; gadolinium, 157.47; ytterbium, 173.62; and yttrium, 89.40. T. H. P.

937. *Absolute Atomic Weight of Dysprosium.* G. D. Hinrichs. (Comptes Rendus, 143. pp. 1143–1145, Dec. 24, 1906.)—The author has applied his method of absolute calculation to the data recently obtained by Urbain for the determination of the atomic weight of dysprosium [Abstract No. 884 (1906)]; he concludes that the absolute atomic weight of dysprosium is 162.5 exactly. D. H. J.

938. *Relation between Diamonds and Garnets.* J. R. Sutton. (Nature, 75. p. 488, March 21, 1907.)—H. S. Harger having pointed out that diamonds occur embedded in garnets, the author shows that the converse also holds. A diamond found at the Wesselton mine, Kimberley, weighing about 1 carat, contains an irregular garnet of 0.1 carat. H. B.

939. *Macroscopic Study of Iron.* W. Ast. (Report of Internat. Assoc. for Testing Materials, Brussels, pp. 106–108, 1906. Metallurgie, 4. p. 123, Feb. 22, 1907.)—The author reports on the extent to which the macroscopic examination of etched specimens has hitherto been applied in practice. Etching with acids is more especially suitable for showing the presence of impurities; iodine and cuprammonium chloride are useful in the case of cast irons. F. R.

940. *Metallurgy of the Martin Process.* T. Naske. (Stahl u. Eisen, 27. pp. 157–161, Jan. 30; 191–194, Feb. 6; 229–236, Feb. 13, and pp. 265–269, Feb. 20, 1907. Electrochem. Ind., N.Y. 5. p. 139, April, 1907.)—The results of this long paper cannot be briefly abstracted to be of value. The sections of the work are: The action of manganese as an oxygen bearer, Behaviour of silicon and carbon during oreing, Behaviour of phosphorus during oreing. F. R.

941. Relative Elimination of Iron, Sulphur, and Arsenic in Bessemerising Copper-Mattes. **E. P. Mathewson.** (Amer. Inst. Mining Engineers, Bull. 13. pp. 7-14 Jan., 1907.)—Results are tabulated and plotted which were obtained from three converters. **F. R.**

942. The System: Ferrous Sulphide—Cuprous Sulphide. **H. O. Hofman, W. S. Cayple, and E. E. Harrington.** (Amer. Inst. Mining Engineers, Bull. 13. pp. 25-36, Jan., 1907. Metallurgie, 4. pp. 252-254, April 22, 1907.)—The authors' study of the solidification and microstructure of mixtures of FeS and Cu_2S leads to the conclusion that these bodies form a eutectic containing about 86 per cent. FeS and solidifying at 850° , but that they form no compound. The eutectic does not occur beyond 20 per cent. FeS and 80 per cent Cu_2S . **F. R.**

943. Interaction of Chlorine and Hydrogen. **C. H. Burgess and D. L. Chapman.** (Chem. Soc., Journ. 89. pp. 1399-1434, Sept., 1906.)—No evidence can be obtained of a period of photochemical induction with a moist mixture of chlorine and hydrogen in the absence of impurities which, under the conditions of the experiment, are capable of being destroyed. There is not sufficient evidence to justify the conclusion that condensation nuclei are formed by the action of light on moist chlorine. [See also Abstract No. 1082 (1905).] **T. H. P.**

944. Studies on Indicators. Part I. Use of Indicators in Measuring Affinity. Part II. Use of Indicators in Volumetric Analysis. **E. Salm.** (Zeitschr. Phys. Chem. 57. pp. 471-501, Dec. 21, 1906.)—Standard solutions of exactly defined ionic content were first prepared, and the colours of indicators added to these standard solutions were noted. The tabulated results of this colour study are given in the original and may be applied to the rapid and accurate determination of the ionic hydrogen content in any unknown case. **D. H. J.**

945. Double Refraction in Colloids produced by Electric Endosmose. **H. W. Malcolm.** (Phil. Mag. 12. pp. 548-556, Dec., 1906.)—When endosmose is produced in a colloidal solution by an electric current double refraction is also produced. The experiments described are devoted to the study of this phenomenon in liquid gelatine, silicic acid, ferric hydroxide, and albumin under different voltages. **T. H. P.**

946. Electrolytic Oxidation in Presence of Fluor-ions. **M. G. Levi and F. Ageno.** (Accad. Lincei, Atti, 15. pp. 549-555, Nov. 4, and pp. 615-620, Nov. 18, 1906.)—Skirrow showed in 1902 for the first time that electrolytic oxidation is facilitated by the presence of fluorine in the form of ions. The present authors have studied the following cases from Skirrow's point of view, viz., oxidation of chromium salts to chromic acid, of sulphites to sulphates and dithionates, of ammoniacal salts and ammonia to nitrites and nitrates, and of manganese salts to permanganic acid. **D. H. J.**

947. Adiabatic Determination of the Heats of Combustion of Organic Substances, especially Sugar and Benzene. **T. W. Richards, L. J. Henderson, and H. L. Frevert.** (Amer. Acad., Proc. 42. No. 21. pp. 573-593, March, 1907. Contribution from the Chem. Lab. of Harvard College.)—To diminish radiation and eliminate corrections the calorimeter was surrounded by a liquid, the temperature of which was varied (by neutralisation of acid by alkali) so as to keep pace with the change in temperature of the calorimeter. **A. F.**

948. Diffusion of Solutions of Copper Sulphate in Gelatine. **Yégounow.** (Comptes Rendus, 143. pp. 882-884, Dec. 3, 1906.)—The equations previously deduced [Abstract No. 1812 (1906)] for the diffusion of copper sulphate in gelatine are confirmed and the experimental and theoretical values of the constant a are given for solutions in 10 per cent. gelatine solution of copper sulphate of concentrations varying from N to $N/200$. **T. H. P.**